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THE PELAGES AND COLOR CHANGES OF THE SNOWSHOE HARE, LEPUS AMERICANUS PHAEONOTUS, ALLEN

BY WALLACE B. GRANGE

[*Plates 6–8*]

HISTORICAL SKETCH

The color changes of the snowshoe hare have been a subject of scientific discussion for almost 150 years. Pennant (1784) stated that the animals grew a new coat with the approach of winter, but that they retained the original summer coat as well. Sir John Richardson (1829) believed the changes to occur from a lengthening and blanching of the fur. Welch (1869) decided that the color changes were due to an actual change in the existing hairs, and not to a new growth of pelage. Allen (1894) published a most excellent paper, based upon a study of museum skins, in which he explained the color changes as normal molts and the renewal of the pelage by new hairs of different color.

For many years it seemed that the work of Allen had set the matter at rest, but in 1929, Hadwen on the basis of observations on captive animals and skins, decided that the molt was of partial character, and apparently rejected the idea of any complete molt. He states: "At no time during the year has the writer seen a heavy moult, such as one finds in tame animals—." And, again: "However, though some shedding goes on, during the change, it represents only a very small percentage of the total hair covering. It has never seemed probable that the rabbits would shed all their hair in the autumn and replace it during the early part of the winter when they are in need of warmth." And, further on, he states: "Another fact which is contrary to the theory of new growth is the comparatively short period during which it occurs."

Hadwen apparently concluded that there is an actual change of color in individual hairs, this probably being a destructive process such as the shrinking of the cores of the hairs, or the entrance, within the core, of air. He also concluded, on the basis of captive hares kept in a steam heated room for many months, and which changed color almost normally, "that environmental factors can be ruled out."

HISTORY OF THE PRESENT STUDY

The present study was begun in 1925 while the writer was living near Ladysmith, Rusk County, Wisconsin, and was continued at intervals in the next several years at Ann Arbor, Michigan, and later in Door County, Wisconsin.

General acknowledgments have been made in a previous paper, (*Journal of Mammalogy, vol. 13, no. 1*), but we wish to acknowledge, in addition, many courtesies extended by the University of Michigan, Museum of Zoology, Ann Arbor, especially to Dr. Lee R. Dice; the University of Wisconsin, Department of Zoology, Madison, especially to Professor George W. Wagner; the Carnegie Museum, Pittsburgh, Pa.; the U. S. National Museum, Washington; the Biological Survey, especially to A. H. Howell, E. A. Preble, W. L. McAtee, and N. H. Kent; and to the many mammalogists, to whom individual acknowledgment is not possible because of lack of space, who have made up the many study skins that we have examined. To F. J. W. Schmidt and Harry F. Johnson, who made skins of young hares of known age, we are especially indebted.

Approximately thirty captive hares, of both sexes, were observed in the present study, besides many, both captive-born and wild, of all ages from birth to maturity. Several of these individuals were kept under regular observation and were examined in the hand under ether anesthesia. Others were observed in small cages and were examined in sacks, without anesthesia, while still others were observed without handling of any kind, in out-of-door pens. The writer has also been familiar with the snowshoe hare in its native haunts.

In addition to these observations on both captive and wild living specimens, examination has been made of several hundred museum skins, taken over virtually the entire range of the *Lepus americanus* group, and these examinations have been supplemented by others on the *Lepus townsendii* and *Lepus arcticus* groups.

The present study is confined, however, so far as conclusions are concerned, to *Lepus americanus phaeonotus* Allen, the Wisconsin and Minne-

sota form of the snowshoe hare; the pelage changes, however, appear to be very similar in the other species and groups.

This report is concerned only with the external manifestations of the pelage changes. Binoculars (5x to 17x) have been used in determining the banding patterns of individual hairs. It is hoped that a careful description of the various pelages and of the external manifestations of the color changes will encourage other workers to a consideration of the *internal* structures of the hairs and the many physiological problems that the color changes bring to mind.

THE PROTECTIVE VALUE OF THE CHANGES

The protective coloration of the snowshoe hare can scarcely fail to elicit the comment and speculation of persons who live intimately with these animals in their native haunts. In the summer period the brown hares are inconspicuous, both because it is difficult to see them and because they make good use of ears and legs in avoiding intruders. At the time the leaves are falling in autumn, it will be noticed that the feet and underparts of the animals are distinctly whitened. Late in November individuals in the half-way, or "grayback," stage may be found. Early in December "pure white" hares are to be seen, and ordinarily by Christmas, in the latitude of northern Wisconsin, all the animals have assumed the white winter pelage.

Throughout the snowy and blustery winter period the snowshoe hare hops stealthily over the crust and loose snow, almost like some phantom creature, rendered relatively inconspicuous by its white coat. By late winter the surface color of the pelage is somewhat mottled, and by the time of the spring thaws it may even appear dirty. From this time on an increasing surface evidence of brown is seen, and it sometimes appears that the change from white to dark has taken place almost over night. As the spring progresses, the surface tone changes from a russet to the less showy brown of summer, but well into May or even in June the feet of the hare may still be white, though inconspicuous so long as the animal remains quiet.

So, in a general way, the color at any particular season rather closely approaches the prevailing tone of the environment. The protection is not always perfect, by any means, and numerous cases of obvious imperfection are known. Thus, on December 4, 1920, in Rusk County, Wisconsin, snowshoe hares, virtually in full winter dress, were hopping about on fallen leaves that had no snow covering. The month was unusually mild, with practically no snow until the middle of the period.

By Christmas, however, there was a heavy blanket of snow and the hares were inconspicuous.

It appears to us that there is not necessarily any correlation of the time or degree of the pelage change with *immediate* climatic conditions. Hares may occasionally be white while the background is dark, or still be brown when the snows appear. What is important is the fact that there does seem to be a very definite correlation between the pelage color and the *average* climatic conditions that cause a change of environmental background. In other words, the assumption of the pelages is such as to provide the wild hare with a coat colored to match the average environmental background that may be expected for a particular season. The success with which this average situation is met is often almost miraculous.

A significant fact, also, as is readily shown by the examination of museum specimens, is that hares from northern latitudes assume the white coat earlier and retain it longer than do those living farther South. It is also of interest to note that these northern specimens have richer and fuller coats than do the southern ones, indicating a correlation between quality of pelage and temperature.

When we come to consider other species and groups of hares, we find that *Lepus washingtoni*, of the humid, rainy Pacific Coast region (with the possible exception of individuals in high altitudes), does not assume the white coat at any time, whereas *Lepus arcticus groenlandicus*, from Greenland, is not known to assume the brown coat at any time. Between these two extremes are all degrees of change: *Lepus bairdi*, of the Rocky Mountains, has white feet the year round; *Lepus americanus* is white for a longer period in upper Canada than is the case with the same species in lower latitudes. While the species mentioned represent several groups of hares, this does not invalidate the conclusion that there is a very definite correlation between the time (and length) of change of pelage color and the time (and kind) of average background of the environment.

PROTECTIVE COLOR IN RELATION TO HABITS

No one who has hunted snowshoe hares could well doubt that the animals make full use of their color to escape detection, or that their habits are modified in this direction. These hares seem by habit ever to play the part of caution, retreating deliberately and slowly, or "freezing," as long as these leisurely tactics suffice. When the animal realizes that they do not, however, the giant hind feet and the long springy legs

can snap into action with incredible speed and project the animal along its runway at a great pace. Even so, the hare is likely to go but a little way before it squats low, or if the situation calls for haste, sits up, ears attentive, nose quivering, and every muscle ready for a quick get-a-way when the danger really materializes.

Hares often sit quietly until one has passed them by, yet perhaps there was no special concealing cover of any kind other than the snowy background upon which they were crouched. It also happens frequently that they move, a few hops at a time, at the first sight of an intruder and have so moved out of visible range without his having been aware of the fact.

Near Ladysmith, Wisconsin, both cottontail rabbits (*Sylvilagus*) and snowshoe hares may occur in the same woods, and here it may be easily observed that the brown cottontails are at a serious disadvantage, spending much of the time in logs and ground dens and making away at full speed rather than sitting in the open or hopping stealthily out of sight. There can be little question that the protective adaptation of pelage color, and the ability to blend it with the seasonal background, has been an important factor in the evolution both of structure and habit.

DESCRIPTION OF THE PELAGES

Having thus pointed out the general rôle the pelages play in the lives of snowshoe hares, we may proceed to a detailed description of the various pelages and of the changes. Before doing so, it is well to remark that in considering these changes we do not have the simple situation that would exist if the hairs were of one uniform color in summer, and of another uniform color in winter. It is not a question of a black pelage, for example, being replaced by a white one, but rather involves the replacement of one variegated pelage by another variegated pelage. In fact, the pelages are so complex as to be very misleading if not examined with the greatest of pains, a fact which has no doubt been responsible for the many different conclusions of various observers.

THE ADULT SUMMER PELAGE

Types of Hairs.—In the summer pelage of *Lepus americanus phaeonotus* there is a wide variety of types of hairs as to coloring, and several types as to size. Some individual hairs are very coarse, straight, and long, though extremely attenuated basally; others are very fine, curly, and difficult to see; and there are hairs of intermediate sizes.

As to coloring, some hairs are uniformly of one color; the majority are particolored, or banded, the color, width, and arrangement of the bands varying greatly; a few seem to be of diffused coloring. Under a low-power binocular microscope we have found no less than 23 types of hairs, classified on color arrangement alone. These include, naming the colors outwardly from the base of the hair

in each case, the following combinations: Pure black (of two sizes, one coarse and straight; one fine and curly); pure white (similarly, of two sizes); brown; ochraceous; white, diffused with rusty or ochraceous; white, black; white, brown; white, brown, black; white, black, brown; white, black, brown, black; black, white; black, brown; black, brown, white; black, brown, black; black, white, black; black, ochraceous, white; black, brown, white, black; black, brown, white, brown, black; black, brown, buff, brown, black; black, ochraceous, black; brown, white; ochraceous, white; brown, black, brown, white.

Undoubtedly, this wide variety of hairs has played a part in the confusion that has existed concerning the color changes of these animals.

Description.—In the following description of the summer pelage, taken from a number of Wisconsin specimens, no attempt is made to analyze the proportions of the variously colored hairs, the description being, rather, of the prevailing surface color or tone.

The prevailing color is bright ochraceous or rusty brown. Nose, dark brown to black, the nostrils edged with pure white. An area from a point tangent with the fore corners of the eyes and extending to one tangent with the posterior corners of the nostrils, rather light brown, flecked with black, the general cast being nearest to a buffy brown.[1] Crown, deep dark rusty brown, between rusty brown and brussels brown; a tuft of several white hairs forming a "star." Eye ring, from a warm buff to buckthorn brown. Cheeks, nearest dresden brown, varying greatly in individuals. Chin, white. The crown patch is distinctly redder and darker than the rest of the head pelage. Nape, very fine grayish brown. Dorsal surface, much less rusty than the crown, the prevailing tone approximating buckthorn brown, strongly intermixed with which is black but varying from buff to gray in individuals. A somewhat indistinct median line of prevailingly darker color is noticeable in most individuals, occasionally approaching pure black. More black on the rump area; upper side of tail nearly pure black, bordered with brown. Under surface of tail, gray to whitish. A tinge of black also is noticeable on the hips and upper portions of the hind legs. Sides, lighter and more buffy, with less black. Hind legs, inner surface, white; anterior border of hips conspicuously edged with ochraceous tawny, more or less edged with black, dorsally. Outer surface of legs, about as on rump, but lighter. Hind feet, ochraceous tawny above, underlain by plumbeous and white; soles of feet, dusky. Fore legs, bright ochraceous tawny from chest to toenails, and on inner surface, white to ochraceous buff. Soles of fore feet, dusky. Chest, ochraceous buff to buckthorn brown, forming a "ruff" or girdle. Belly, pure white to dirty grayish white, bordered imperfectly by ochraceous buff. Ears: Convex portion of ear, anterior of median crease, about as on the crown, but blacker, the tips pure black, and posterior of the crease, very thinly furred with gray, the prevailing cast. Concave surface, or hollow, of the ear with a conspicuous pure white border on the posterior or outer edge, and basally on the anterior or inner edge, the white often bordered, inwardly, with pure black. Further inwardly, brown, about as on the cheeks, the middle portion of the ear being bare or very thinly haired with grayish.

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[1] Color names are mainly from Ridgway, Color Standards and Color Nomenclature, 1912.

Specimen No. 6301, University of Wisconsin, Clark County, Wisconsin, is cited for reference as typical, but with some variation noted on the feet.

THE ADULT WINTER PELAGE

Types of Hairs.—We have found the following types of individual hairs in the winter pelage (classified on the basis of color arrangement, and naming the colors outwardly from the base): Pure black; pure white (of several sizes, from very fine to very coarse, and including coarse-tipped hairs very much attenuated basally, as well as the curly, coarse white hairs of the soles of the feet); white, black; white, ochraceous, white; black, white; black, ochraceous; black, ochraceous, white; black, ochraceous, black; black, white, brown, white; plumbeous, white; plumbeous, black, white; plumbeous, ochraceous, black; plumbeous, black, brown, black; plumbeous, black, brown, white, brown, black; white, ochraceous.

Description.—The winter pelage is relatively easy to describe, consisting of fewer types of hairs. The surface appearance of individuals in perfect winter pelage is pure white, except for the ears, which may be tinged with brown or rusty, and which are tipped (convex surface) with black; and the feet, which are frequently tinged with ochraceous tawny above, dusky or yellowish on the soles.

By blowing the pelage, three zones of color, underlying the outer and longest one of white, are seen, namely (proceeding inwardly), a band of ochraceous tawny or sometimes approaching buckthorn brown, then a very narrow band of warm buff, and, basally, a zone of dark plumbeous. The purity of the surface white varies in individuals, and with the season, but it has been noted by others, and is apparent in skins, that *phaeonotus* has a relatively thin white surface zone, compared to snowshoe hares from farther north. Wind sometimes parts the surface fur, permitting the darker underfur to show through. As will be noted under the color-change account, the animals may, by spring, have a very blotchy or patchy appearance.

The prevailing whiteness of the winter pelage results mostly from the coarse white guard hairs, very finely attenuated basally, which occur in great profusion. The underfur is sometimes narrowly tipped with white, but it apparently does not contribute much to the white surface appearance, as by plucking out the white guard hairs little whiteness remains.

Specimen No. 4882, University of Wisconsin, Ladysmith, Wisconsin, is cited for reference as typical, although the feet are less rusty than in many specimens.

THE PELAGE AT BIRTH

Types of Hairs.—We have found the following types of individual hairs in newly-born young (classified as to color pattern only, and naming the colors outwardly from the base in each case): Pure black (both large, straight hairs and very fine curly ones); pure white (also of the above two types), diffuse rusty white; brown; ochraceous; ochraceous, white; brown, white; black, white; black, brown; black, brown, black; black, brown, white; black, ochraceous, black; black, white, black; black, ochraceous, white; black, brown, white, black; black, brown, white, brown, black; black, brown, ochraceous buff, brown, black.

Description.—The general cast of the fur of the young at birth is dull grayish,

this underlain with darker fur. There is, however, considerable variation, some individuals presenting a brown rather than a gray appearance.

Close inspection of the head reveals some extremely delicate tints about the eyes, ears, and nostrils. The fur is remarkably long on the dorsal surface—as long as three quarters of an inch. Most of the hairs are of the particolored type, although some hairs of uniform color are to be found. The fur has a dull rather than a glossy appearance.

In the following description, the prevailing surface color, rather than an analysis of the component hairs, is given.

Nose, between forks of characteristic nostril Y, blackish, the Y itself approaching light buff, edged with white. Surrounding this, a conspicuous broad oval disk of brown (between buckthorn and dresden). Eye ring, of pale orange yellow, surrounded by a broader ring of brown, again between buckthorn and dresden, but decidedly tinged with black. The nasal and eye areas of brown sometimes join but sometimes are separated by very bright silvery hairs. Crown and cheeks, ranging in individuals from bright silvery white, liberally sprinkled with black and buckthorn brown to ivory yellow, liberally sprinkled with black and silver. Chin and throat, white. Pupil of eye, bluish black; iris, brown. Ears, convex portion anterior to median crease, similar to crown, but browner and with a spot of black at the tip; outward portion of ear from the crease, thinly haired, the outer border of pure white edged inwardly with black; and at the outer base, white. Concave portion, or hollow, of ear, bare in center, surrounded by rich apricot buff, with a slight tinge of white and a small spot of pure white at the outer base. Dorsal surface, ranging in individuals from ivory buff to silvery or light brown, but in any case presenting a flecked or grizzled appearance. Rump, sides, and hips decidedly grayer than back. The black underfur shows through the prevailing surface color, giving some individuals a darker appearance than others. Sides, grayish. Hind legs, inner surface, grayish white; outer surface about as on back, but with much more ochraceous tawny, and with an anterior edging of rich ochraceous buff. Hind feet, ochraceous tawny to light buff above, flecked with black. Soles, plumbeous; between toes, white. Fore legs, ochraceous tawny, prominently flecked with black above; grayish white below. Fore feet, ochraceous tawny above; soles, light buff. Chest, light brown, approaching ivory yellow or warm buff. Belly, grayish white. Tail, similar to back, but darker, above; below, as belly.

Specimens No. 6718 and 6717 (young 90 hours old), and No. 6719, (young 4 hours old), University of Wisconsin, Fish Creek, Door County, Wisconsin, represent the average pelage and are cited for reference. They are not as gray as some specimens.

THE PELAGE OF IMMATURE SPECIMENS

The pelage at three weeks of age shows little difference from the birth pelage. It is to be noted that the fur of newly born young and of animals up to several weeks of age is decidedly more downy and fluffy than in the case of adults. Specimen No. 6716, University of Wisconsin, male, born August 21, and killed September 12, 1930, Fish Creek, Door County, Wisconsin, is typical and corresponds rather closely with the skins of newly born hares. At two months of age, however, the pelage approaches that of typical summer adults; the general cast is brown, the

gray surface coloring of juveniles being largely gone. This is particularly noticeable upon the head. University of Wisconsin, skin No. 6715, female, born July 14 and killed September 12, 1930, Fish Creek, Door County, Wisconsin, is typical. In this specimen a trace of gray still remains at the base of the ears and upon the crown; elsewhere the gray has disappeared.

While we have not made detailed studies of the juvenile pelage change, it seems probable that the post-juvenile brown coat is the result of the partial molting of some hairs and the new growth of others. It is possible that a complete molt is accomplished; we are not prepared to speak definitely upon this point. However, Specimen No. 9104, University of Wisconsin, female (half grown), September 14, 1901, Michipicoten Island, Lake Superior, shows a profuse growth of new hairs of typical adult summer type scattered through the juvenile wool of the dorsal area.

THE AUTUMNAL CHANGE OF PELAGE

Observations on the autumnal change of color were made in 1927 upon captive specimens, at Ann Arbor, Michigan, (hares numbered 8, 11, 12, 13, and 14). Several experiments in clipping the fur from various portions of the body were made (hares numbered 8 and 13). All but one of the captive hares here reported on were etherized at more or less regular intervals to facilitate detailed examination. This anesthetizing, so far as we could determine, did not affect the manner or degree of change.

Observations on hare No. 8.—A description of the autumnal color change of hare No. 8 (male, wild trapped, spring of 1927, Ladysmith, Wisconsin), will illustrate the normal process. This hare was examined in the hand, generally while anesthetized, on August 14 and 31, September 25 and 27, October 7, 15, and 22, November 1, 10, and 25, and December 7 and 15, 1927.

The August examinations showed the pelage in its normal summer phase. At this time our hare was compared directly with snowshoe hare skins Nos. 48684 and 56552, Museum of Zoology, University of Michigan, for reference. Hare No. 8 was noticeably lighter than skin No. 48684, apparently due to a paucity of pure black summer guard hairs. We are not prepared to say whether black guards had been shed previous to our examination, but believe not; rather that the lack of black guards was the normal condition of our hare No. 8. Our hare, however, was blacker about the cheeks and face than skin No. 48684. Number 8 was also more rusty on the feet and legs and showed more white hairs in the crown, both of these conditions being common in Wisconsin hares.

Museum skin No. 56552 had a "woolly" appearance, possibly from the shedding of hairs. Our hare No. 8 did not approximate this condition at all.

On September 25, an irregular area on the wrists of the fore legs of hare No. 8 was "bright, pure white," and there were scattered white hairs upon the fore feet. The posterior half of the convex side of each ear, (that is, the area on the outside portion of the ear, backward of the longitudinal crease) was pure white, except at the very base, and the distal half of the anterior or heavily furred side (forward of the longitudinal crease) was now sprinkled liberally with white, the base being of summer hairs, which, however, seemed short and worn. The extreme tip of the ear was deep, rich black. The inner hollow of the ear was nearly white except at the base or lower third of the ear, where the hairs were found to be mostly of two

kinds, one black and one white. Toward the base of the ear some brown hairs were also found.

The hind feet showed a more or less uniform distribution of white hairs, almost of the same length as the normal summer hairs. A patch of pure white hair was noted on one toe, and another smaller one on one heel.

The tail region seemed to have lost many of the former black guard hairs. White hairs, not yet visible at the surface of the summer fur, were to be found at the side of the tail and upon the lower rump area.

It seems well to quote from notes on one significant point. "The whole area of the back has far *more black* than when examined on August 31, especially the posterior half. . . . *Animal appears sleek, fully coated and not scraggly* in the least. A decided and rather startling change from August 31. . . No evidence of any white hairs anywhere on the back. *Hairs on the posterior third of the body, dorsal surface, come out readily on plucking*, especially about the tail. Rest of dorsal hairs come out, but not so easily."

Furthermore, all hair removed in August (a small dorsal patch) by the animal's mate had come in *abundantly*, so that the spot was not distinguishable from the rest of the dorsal pelage, which was in typical summer dress on this date (September 25).

We concluded from these observations that (1) the dorsal summer fur had grown and improved in quality since August 31,[2] but that nevertheless, (2) the black guard hairs of the posterior dorsal area were loosening, and (3) the assumption of the white winter fur was in progress upon the ears, feet, and about the lower rump region. (4) It also appeared that hairs from the ears were being shed, the black guards being replaced last.

On September 27, we clipped with scissors the fur on the left hip region, from the median line of the rump distally to the hind foot, and from there irregularly to the toes, one of which was sheared; most of the hair on the left ear; also the distal portion of the left fore leg and foot. The shearing was done as close to the skin as could be managed without injury to the animal. On October 7, careful examination of the fur of the clipped ear showed the hollow or concave side to be pure white, but not as long as that on the unclipped ear. The convex side showed mostly soft, plumbeous fur, but with here and there numerous pure white hairs.

The clipped fore leg and foot were covered with white hairs, and also with some tawny or rusty hairs such as are found normally in winter specimens.

The clipped hind foot appeared mostly plumbeous, but with numerous blunt white hairs scattered through, indicating them to be white hairs clipped on Septemper 27. These blunted, individual white hairs had lengthened, as had also the plumbeous, soft, silky fur. The clipped toe was very deeply and fully furred with white and tawny near the nail, and with plumbeous mixed with white proximally.

The clipped hind ankle showed very dense growth of both winter guard hairs and winter underfur, the guards pure, bright white, the underhairs plumbeous

[2] Biological Survey skin No. 243080, adult female, Herbster, Wisconsin, August 9, 1922, an animal in good summer pelage, clearly shows, upon carefully parting the fur at the base, many new summer hairs coming into view along the upper dorsal median line.

gray, narrowly tipped with tan or yellow. Apparently the white tips of these underhairs were clipped off on September 27. The same condition was noted proximally or upwardly on the lower leg.

On the clipped hip, however, we found a most interesting condition, namely, a lengthening of the plumbeous velvety fur, which now gave the hip area a blackish cast (hairs then about 5 mm. long); and scattered over the hip were fifteen or twenty long white hairs (15 mm. long), some zoned and some pure, indicating them to be of both guard and underhair types, the guards predominanting.

We concluded from these facts that (1) the plumbeous growth on the ears, feet, and hip was not normal winter underfur, but rather the bases of the old summer hairs, and that this growth, though profuse, was not particularly rapid; (2) the long, pure white guard hairs sprang out in the hip region in small numbers for a length of 15 mm. in ten days; these hairs were newly formed, they could not possibly be former summer-colored hairs because these had all been sheared away; (3) a few winter underhairs in the hip region also sprang out rapidly; and (4) the white areas of the feet were extending proximally up the legs.

On October 15, it was noted that the unclipped ear appeared white, underlain with (and also having an admixture of) brown; whereas the clipped ear was mainly white underlain with plumbeous. Some white hairs were to be seen, also, below the surface of these plumbeous hairs. Apparently the brown tips of some hairs were clipped off, and these had not been replaced. The white overhairs of the ears were lengthening, and more were emerging from the skin.

The feet had not materially changed, but no particular growth of guard hairs was found.

In the lower neck region, just forward of the shoulders, many pure white guard hairs (more than 40 mm. in length) were found in the unclipped area.

The guard hairs of the clipped hip region had lengthened by several mm., but not with the same rapidity of the preceding period. The underfur, however, had lengthened to approximately 8 mm.

Two smaller patches had been sheared off on October 7, one on the side, almost at the belly, and one in the mid dorsal region along the median line. Examination on October 15 showed the side patch to be coming in to grayish white hairs, then 10 mm. long. The dorsal patch showed no guard hairs whatever, and a rather short growth of gray or nearly plumbeous fur, too short to clip.

We concluded from the October 15 observations that (1) the rapidity of the growth of the guard hairs on the hip area diminished after the hairs attained 15 mm.; (2) that the hair in the dorsal region was not yet stimulated (for want of a better word) to make the growth observed in the posterior area and on the legs; and (3) that the white areas of the legs and sides were spreading upward.

On October 22, both ears were acquiring rusty-colored hairs of the type frequently seen in winter specimens. The fore feet and legs were in full winter dress (including some of the normal rusty hairs of winter) almost to the humerus area, and in this latter region many pure white hairs were to be seen. The clipped hind foot and leg, almost to the body, were now prevailingly white. The number of long winter guards had increased but with tan noted on some of the hip area. The unclipped hind foot and leg almost to the hip was now rich, deep white, with an admixture of rusty winter hairs. In the unclipped hip area many pure white guard hairs were now almost to the outer surface of the fur, yet were concealed from sight by remaining summer fur.

It is interesting to note (1) that a greatly increased number of white guard hairs was found on the chest region; (2) that the dorsal patch revealed one long white hair and no others of this color, but a short growth of grayish "fuzzy" hairs, through which the skin showed; (3) that the tail was now almost as in winter, but with a few black guard hairs remaining; (4) that in the rump region the summer fur could be pulled out very readily, almost at touch, whereas in the anterior dorsal region plucking required some strength; and (5) that a general extension of the white areas upwardly had occurred.

On November 1 examination revealed a decided change, chiefly in the remarkable growth of the underfur on all parts of the body except in a narrow nose-to-posterior-shoulders zone, and excepting most of the head.

The ears were both noted as now practically in full winter pelage; likewise the feet, legs, and lower ventral region. The clipped hip area showed a very profuse growth of underfur, which had a slightly yellowish cast, and the overhair appeared to be somewhat deficient. On the unclipped side the entire lower half of the animal appeared white at the surface and with both guard hairs and agouti patterned underfur apparently complete.

The clipped dorsal patch contained no more winter guards and had made but a small growth of the grayish fur, now 2 to 5 mm. long. In fact, there was some indication that some summer fur might still be growing. The November 1 observations indicated that (1) a profuse growth of winter underfur had occurred on practically all parts of the body except on the head and along an anterior dorsal median strip; (2) this winter underfur was still largely concealed by summer hairs, which were noted to be "very loose;" (3) the ears, tail, and rump region, the feet; legs, sides, lower hips, and shoulders were practically in full winter pelage, and (4) the clipped dorsal patch showed little sign of change.

On November 10, (1) an extension of the whitened areas was noted, mainly appearing as a contraction of the brown areas as if pushed in from the sides and rump by the increasing white; (2) the clipped hip region appeared practically in full winter pelage, very full and thick, but it is of interest that a very few black guards and a few agouti hairs still remained; (3) the clipped dorsal patch was noted to be growing in to a reddish-appearing mixture of hairs, but with no additional guard hairs yet apparent; (4) the head showed decided change, white spots having appeared in the nasal area, just forward of the eyes, between the eyes and the base of the ears, and on the cheeks.

On November 25 observations showed (1) the head to be white except for a crown patch and a malar patch; (2) the only pure "brown" or summer fur was a dorsal patch about two inches long by one inch wide just back of the shoulders along the median line; (3) the rest of the dorsal area had assumed a prevailingly white cast (the rump and sides being pure white), but was quite grizzled, owing to a considerable number of pure black summer guard hairs yet remaining; the agouti summer hairs were missing and the black guards were very loose; (4) the clipped dorsal patch was now very bright white, winter guard hairs having come in profusely.

On December 7 a small grizzled patch of white winter fur, still containing a few summer hairs, and a few very loose and easily plucked summer hairs in the anterior dorsal region, were the only visible remnants of the summer coat.

On December 15, hare No. 8 was in full winter pelage. This pelage was very

thick, profuse, and soft, probably twice as heavy as that borne in summer. None of the hairs of this pelage (except some pure black hairs on the ears, some pure white hairs such as are found in summer on the belly, and some rusty colored hairs on the ears, chest, and feet) are at all similar to the summer hairs.

Observations on hare No. 13.—On October 7, 1927, this hare (captive-born, August 18, 1927), was clipped on its entire left side, including all appendages. Its pelage growth, though more delayed than that of No. 8, was in all significant details similar with the following exceptions: (1) a crown patch grew in to typical summer overhairs (noted October 15); (2) a much more detailed study of the growth of individual hairs was possible, and it was determined that the winter guards came in first, followed by the winter underfur, and that the plumbeous fur left after clipping was merely the bases of summer hairs; (3) the buff or tan eye ring persisted longer than in the case of No. 8; (4) the change was not completed until early in January; (5) the juvenile white crown tuft was retained until the summer pelage of the crown was shed.

Hare No. 12 (born August 18, 1927) was examined and clipped in small patches, and its change corresponded almost exactly with that of number 13, although a little longer delayed.

Hare No. 14 (born August 18, 1927) was not clipped and was not etherized. Its pelage change corresponded to the others, but was slightly slower, this being the slowest of all our hares to assume the winter pelage.

Hare No. 11 (born July 2, 1927) was not clipped. Its pelage change was also slower than that of adult hare No. 8. On November 10, it was noted that the summer hairs of the dorsal area were very easily dislodged, and that the summer fur of this area was thin, much of it having been molted. This hare commonly had a more ragged, woolly appearance than the others, as tufts of summer fur hung on here and there all over the dorsal surface even when the winter pelage was nearly completed.

THE VERNAL CHANGE OF PELAGE

Observations on hare No. 8.—The spring change of color was observed on hare No. 8, in 1927, but without anesthetizing the animal. It was, however, examined frequently in a sack, so that close observation was possible.

The spring molt in this hare corresponds in all important details with that of hare No. 7, and with other hares that we have observed. As observed on March 17, the animal was in its winter coat, but considerable shedding had already occurred, the tawny underfur showing through the remaining guard hairs to some extent, and the tips of many of the underhairs already worn off. Many of the remaining guard hairs were very loose.

By March 30, the majority of the winter guard hairs from the head nearly to the rump had been shed, giving a decidedly tawny or reddish brown cast to the dorsal surface of the animal, because of the worn underfur that was thus exposed and whose white tips were largely worn off. There were a few tufts of summer fur to be seen in the dorsal area, scattered about in four or five places. The rump was woolly in appearance, with no summer fur visible at the surface.

The head had an almost solid patch of new summer fur just forward of the eyes, though there were still a few white hairs intermixed. The feet, sides, and belly appeared almost unchanged. The dorsal area normally covered by the ears when

these are laid back upon it was still bright white. The chest area appeared unchanged.[3]

On April 15 and 17 it was seen that the head patch had progressed rapidly, the brown summer fur extending between the eyes from about the base of the ears and to and around the nose. There were still a few white guard hairs on the forehead. The white neck region had assumed a brown cast.

The dorsal area had a grizzled appearance, caused by the intermixture of new summer fur with the remaining tawny underfur of winter. This gave the animal a ragged and somewhat unkempt appearance. Here and there in the dorsal area small tufts of loose white guard hairs remained but in most cases these areas were fast disappearing. Some of the underhairs still had white tips, but most of the tips had been broken off. The feet, rump, and sides still retained very much the same appearance as in winter. The ears were nearly brown, as in summer.

On April 28, the crown, face, ear, and nasal regions were approximately in summer pelage. The cheeks were still whitish with the tips of winter underhairs, which were not much worn.

The dorsal region, with the exception of the rump and the neck area, had taken on the summer pelage, but with some woolly winter underfur still in evidence. Numerous pure black hairs of summer were to be seen. The shoulder area still retained a great many of the winter guard hairs, as did the lower chest region.

The legs and feet were unchanged, except for the forelegs, the sides of which were turning rapidly. The area affected was somewhat higher up on the leg than that first affected in fall.

On May 14, the rump, lower chest, sides, neck, and feet were still more or less as reported on April 28, but the summer fur was rapidly approaching the surface on the rump and hips, presenting a variegated appearance. The hind leg was assuming its beautiful bright tan or ochraceous edging anteriorly, and the hip area of summer fur was enlarging posteriorly. The tail had assumed the color of summer. The main dorsal area, the head area, and the fore-leg patch were all slowly extending. The feet, too, were speckled here and there with tufts of summer fur visible at the surface. The hind feet, however, were still clear white.

The hare appeared brown when at rest, but when in motion the rump area and and the feet were conspicuously white.

By May 25, the dorsal area of summer fur had extended backwards toward the

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[3] Biological Survey skin No. 18596, female, Hinckley, Minnesota, March 27, 1890, is a snowshoe hare typical of the season, the worn pelage of winter appearing brown, but with some pure white guard hairs about the rump and sides. By carefully parting the fur, at the very base a profuse growth of new summer fur is to be found on the crown, shoulders, back, sides at their ventral borders, rump area at the tail, and upon the neck, nose, chest, and hips, but apparently *not* on the lower legs, feet, throat, tail, and ears.

The same condition at a later stage is clearly revealed by University of Wisconsin skin No. 7084, Fish Creek, Door County, Wisconsin, April 25, 1930. In this specimen much of the back is already in summer dress, and on the rump, which at the surface is still largely of winter underfur, the new growth is visible upon parting the fur.

tail, but some winter guard hairs still remained in the rump region, and much winter underfur was in evidence. The rump region, however, now appeared brownish in general cast. Along the median line a belt of darker color, due to the more luxuriant growth of pure black summer overhairs, was in evidence. The woolly winter underfur on the hips was now much restricted, and existed posteriorly as a triangular patch. The shoulders and the lower chest were almost unchanged, still retaining some of both types of winter fur. The feet were assuming the brown pelage of summer, and the fore-leg summer area was extending both downward and upward. On the cheeks, at the base of the skull, behind the ears, and on the chin there were still some white winter guard hairs.

On June 11, a careful examination indicated that almost full summer pelage had been assumed. The completion of the molt seemed to be much accelerated, the dropping out of the winter hairs and the growth of the new summer hairs culminating almost at the same time. A few small tufts of winter fur on the hind feet, on the shoulders, and on the sides remained, but these were fast falling out.

On June 21, all evidence of the winter coat had disappeared and the animal was in full summer pelage.

DATES OF COLOR CHANGE IN THE WILD

The general progress of the color change and the length of the periods involved seem to correspond fairly well for wild hares in Rusk County, Wisconsin, and for the captive hares under observation at Ann Arbor, Michigan. The following field notes made by the writer are of interest.

On December 4, 1920, with no snow on the ground, snowshoe hares that were virtually in full winter pelage were seen and several specimens collected. Some were more brown than others, but several were in the "grayback" stage, in which the white coat is complete except for a grizzled median dorsal area. At the close of the month some sixteen inches of snow covered the ground.

On September 25, 1921, we noted a hare that was assuming the white pelage on its feet, belly, and ears. On October 2, 22, and 30, hares were seen and specimens taken that were in various stages of change; that of October 22 being classed "three eighths" white, and the specimen on the 30th showing a sprinkling of white hairs over much of the dorsal region. On November 20 it was noted that wild hares ranged from about "half brown" (to the eye, without close observation in hand) to "graybacks" almost in full pelage. On December 10 a specimen was collected in full winter dress.

In 1922, a specimen taken November 14, was prevailingly brown on the dorsal region except the rump, which, with the ears, feet, belly, and the hind legs, was white. On November 30, three specimens were each in the gray-back stage, with some brown on the heads, and one on December 1 was similar.

Regarding the spring change of color in the wild, a hare taken from a log on March 5, 1921, was apparently in winter pelage except for the loss of guard hairs; one on March 12 was about the same; one on March 30 showed change, especially by the wear of the underfur and the shedding of the winter guard hairs, thus giving the animal a tawny or tan color. There was no snow on the ground at this date, so that the animal harmonized well with the background.

On April 3 the change was noted as advanced upon the back. Frogs and worms were about on this date, but on April 9, 15, 27, and 28 there was snow, cold, and

unsettled weather. In this seasonal transition period, the wild hare is also in a transition color phase; often about as much white as brown.

I have seen white hares hop from snow patch to snow patch over bare brown patches of leaves. This does not necessarily mean that the hares deliberately select a background to match their coat; they may prefer snow for some other reason, such as coolness; the point will bear much further study. They often sit in plain sight against brown backgrounds even when snow is available.

A specimen on February 25, 1922, was approximately as in winter; on March 5, one was seen with brown feet. On March 19 a hare seen was partly brown. On March 20 another hare was practically all white, with many guard hairs apparently still hanging on. On March 28, two hares seen at a distance appeared, respectively, brown and white. On April 3, one was seen with the tawny underfur very prominent, and the animal's pelage appeared to be a mixture of brown and white. On April 9, one seen was brownish, but the posterior third of the body still white, and on this date the ground was generally bare. On April 11, during a snowstorm, two hares were seen and collected; one was mainly tawny on the head and back, with the rump and posterior third of the body mainly white, ears and all four feet and legs mostly white, and throat mixed tawny and white (apparently pure winter pelage). A few tufts of white hairs were scattered in the fur of the back. The other hare was mainly white, with about half of the head brown. It was noted that the new underfur was well grown and much of the white overhair had been shed. This animal was a male, whereas the browner animal was a pregnant female. On April 16 several hares were seen, one "quite brown," one "quite white," and one was particularly noticed because it had a very white face. On April 22, two hares were seen, both nearly brown in general aspect, except for the rump and the hind legs. A hare in about the same stage was seen on April 24, the feet being all white. On May 21, a specimen collected was found to have the feet still whitish but, otherwise almost identical with the summer pelage.

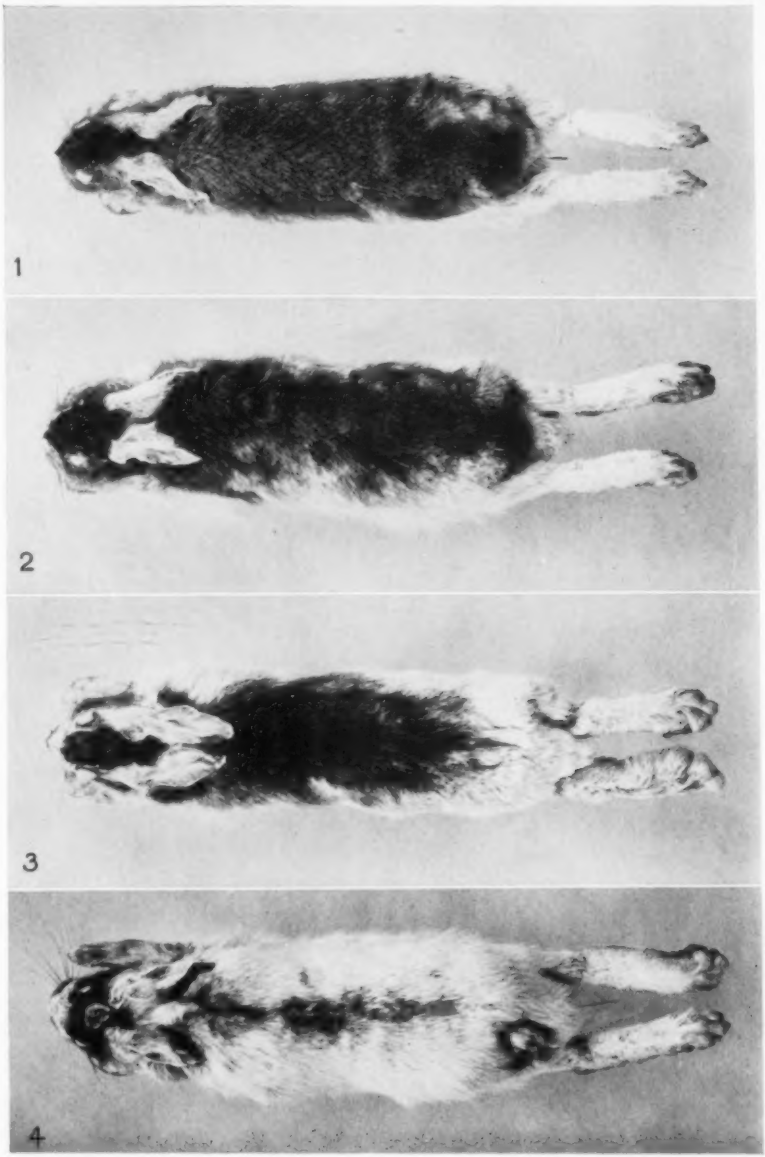
SUMMARY OF PELAGE CHANGE OBSERVATIONS

(1) The seasonal color changes of the snowshoe hare found in Wisconsin result from a molt (complete on all parts of the body, so far as we can determine) involving the replacement of the shed hairs with other hairs characteristic of the ensuing pelage, thus confirming J. A. Allen's work (1894).

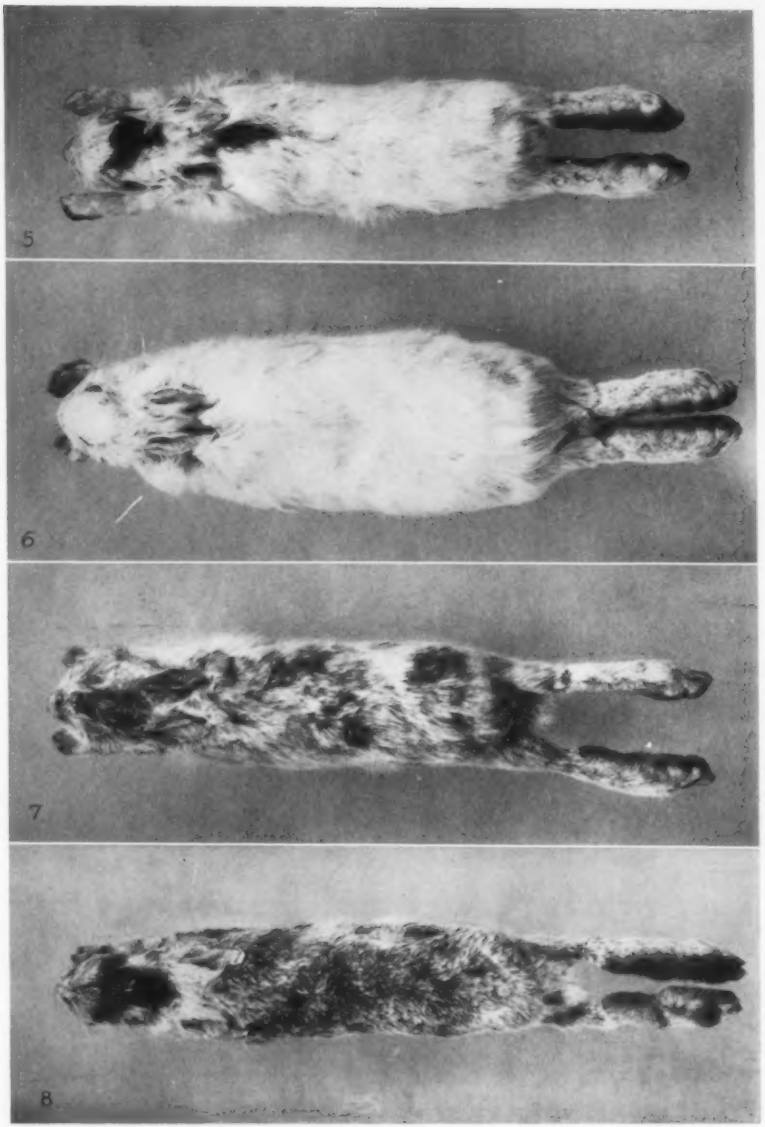
(2) The sequence of the change in autumn, as to parts affected on one individual is quite regularly as follows: The ears, wrists, and portions of the feet; the feet and the legs, together with the lower rump and tail area; the upper legs, sides, rump, belly, and the bases of the ears; the sides of the face, the chest, shoulders, hips, and lower back; the remainder of the head and the upper back; the median, dorsal shoulder area, and the crown, and sometimes a narrow ring about the eyes.

The sequence of the spring change is, also quite regularly, as follows: A more or less general shedding of the pure white guard hairs and a more or less general breaking off of the white tips of the winter underhairs, giving the animal a brownish, tawny appearance; the ears, nose, and head area; the upper dorsal region; the shoulders, and areas about the lower forelegs; the hips, upper legs, and the chest; the lower legs, rump, and probably the belly; the hind feet and tail area.

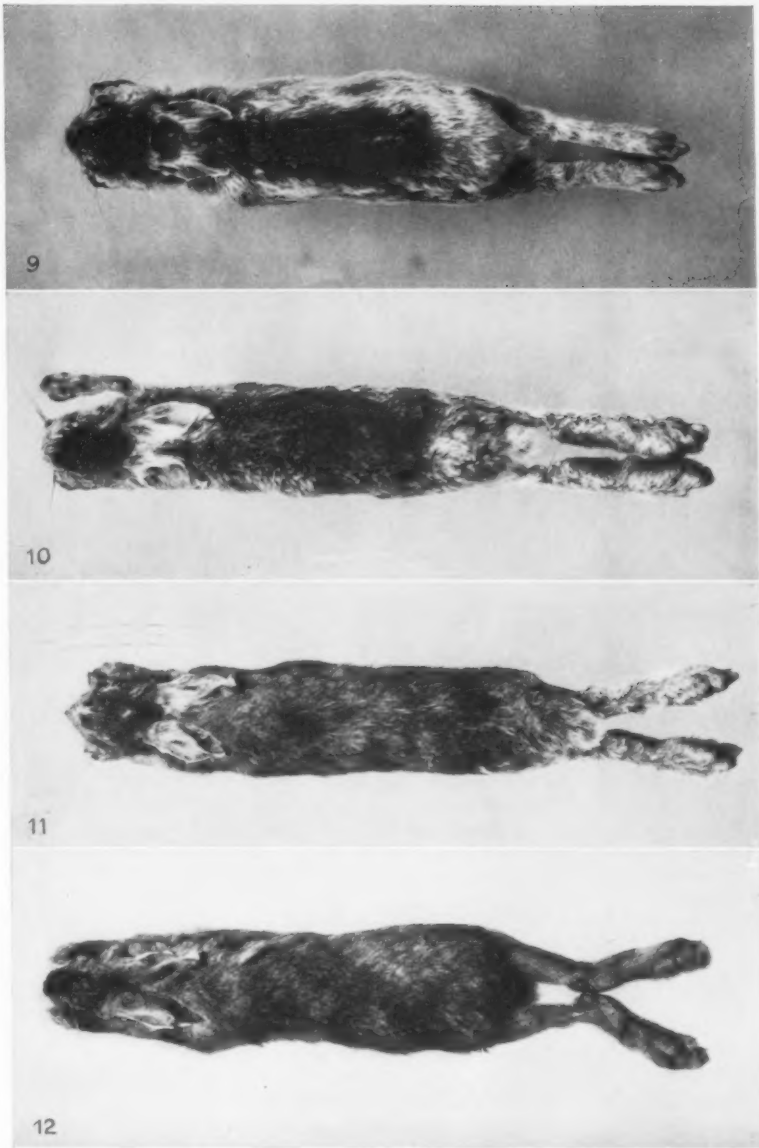
(3) There is, however, considerable variation in the change of pelage, as re-



FIGS. 1–4: TYPICAL PROGRESS OF THE AUTUMNAL CHANGE OF COLOR IN LEPUS AMERICANUS, REPRESENTING INTERVALS OF APPROXIMATELY TWO WEEKS DURING OCTOBER AND NOVEMBER



FIGS. 5–6: TYPICAL PROGRESS OF THE AUTUMNAL CHANGE OF COLOR IN LEPUS AMERICANUS DURING EARLY DECEMBER (CONTINUED FROM PLATE 6)
FIGS. 7–8: TYPICAL PROGRESS OF THE VERNAL CHANGE OF COLOR AT INTERVALS OF APPROXIMATELY TWO WEEKS DURING MARCH



FIGS. 9–12: TYPICAL PROGRESS OF THE VERNAL CHANGE OF COLOR IN LEPUS AMERICANUS, REPRESENTING INTERVALS OF APPROXIMATELY TWO WEEKS DURING APRIL AND MAY (CONTINUED FROM PLATE 7)

gards individuals, in both the degree of change in the same locality and at the same time, and as regards (less commonly) the order of the parts affected.

(4) In the case of captive hares, the young began both the autumnal and the vernal change later, and completed it later, than an adult.

(5) The autumnal change occupied 70 to 90 days in captive animals, and the vernal change occupied 70 or more days, exclusive of that period of shedding in which there was no actual growth of new hair.

(6) The changes of pelage are apparently not correlated directly with *immediate* climatic conditions, but they do show a rather remarkable correlation with the *average* climatic conditions, particularly with the presence or absence of snow.

(7) In captive hares, there was a continuing growth of the typical summer hairs on the parts in which the assumption of the winter coat was longest delayed, even while the typical winter fur was coming in upon those parts of the body first showing the autumnal change. There was no evidence that the summer fur deteriorated before being shed.

(8) In no case was there any evidence whatever that any individual hair changed color directly; change of color was accomplished by a growth of hair of new color, and by the breaking off and shedding of the old hairs (winter underfur). The evidence in support of this conclusion is summarized as follows:

(a) Parts of the body clipped close to the skin came in to full, normal winter pelage, and at almost the same time as corresponding parts of the body left unclipped. *As there were no individual hairs left to change, no destructive process within the hair could be possible.*

(b) Individual hairs, in both clipped and unclipped areas, were found to grow as much as 15 mm. in 10 days.

(c) The winter guard hairs and underhairs could be plainly located under the surface of the overhanging summer fur, and their progressive growth noted.

(d) The summer fur was found to shed readily, and most easily on the parts first affected by the autumnal color change. Large quantities of summer hair were swept up from the floors and litter of the cages, and the quantities thus swept up appeared to be ample to account for the entire summer coat.

(e) Large quantities of winter guard hairs were shed and found in the cages, and ends of the white tipped underhairs also were recovered. The basal portions of the underhairs were temporarily retained, and these gave the animals a prevailingly tawny appearance until these hairs themselves dropped out almost coincident with the arrival of the newly-grown summer hairs at the outer surface of this underfur.

(f) The winter pelage is much longer, heavier, and thicker and is of a different character than the summer pelage. Thus, even if the individual hairs *could* be shown to change color, this would not explain the observed facts.

(8) The shedding of the summer fur does not lessen the warmth of the hare's coat; much of it is retained until such time as a very advanced growth of the new winter fur has occurred.

(9) The winter overhairs are generally well advanced before any decided growth of the winter underfur occurs.

(10) The rusty or tawny hairs of the feet, legs, and chest, in the winter pelage, are not summer hairs but are new hairs of the winter pelage.

(11) The juvenile forehead or crown tuft of white hairs is retained until the crown assumes its winter pelage.

(12) The birth of young, in the wild, may occur before the spring pelage change of the parent has been completed.

(13) The juvenile pelage is supplemented by new hairs characteristic of the summer pelage of adults, and it seems probable that a complete molt is undergone.

LITERATURE CITED

ALLEN, J. A. On the seasonal change of color in the varying hare (Lepus americanus Erxl.). Bull. Amer. Mus. Nat. Hist., vol. 6, art. 4, pp. 107–128. 1894.

AUDUBON, JOHN J., AND JOHN BACHMAN. The quadrupeds of North America, 1849.

CORY, CHARLES B. The mammals of Illinois and Wisconsin, Field Mus. Nat. Hist., zool. ser., vol. 11, publ. 153. 1912.

GRANGE, WALLACE B. Observations on the snowshoe hare (Lepus americanus phaeonotus, Allen). Journ. Mammalogy, vol. 13, pp. 1–19, Feburary, 1932.

HADWEN, SEYMOUR. Color changes in Lepus americanus and other animals. Canadian Journ. Research, vol. 1, no. 2. July, 1929.

NELSON, E. W. The rabbits of North America. North American Fauna, no. 29. 1909.

PENNANT, THOMAS. Arctic Zoology, vol. 1, p. 96. 1784.

RICHARDSON, JOHN. Fauna Boreali-Americana, vol. 1, p. 218. 1829.

SETON, E. T. Life histories of northern animals, Scribners, 1909.

WELCH, FRANCIS H. Observations on Lepus americanus, especially with reference to the modifications in the fur consequent on the rotation of the seasons, and the change of colour on the advent of winter; based on specimens obtained in the province of New Brunswick, North America, Proc. Zool. Soc. London, 1869, pp. 228–236.

U. S. Biological Survey.

NOTES ON THE BEAVER'S INDIVIDUALITY AND MENTAL CHARACTERISTICS

By Alexander H. Leighton

The summer of 1931 I spent afield in Digby County, Nova Scotia, in order to study the behavior of the beaver. This paper will deal with a small part of that work. I am much indebted for permission granted and help kindly rendered by the Department of Lands and Forests, and for the valuable assistance of Mr. Carl B. Miller, forest ranger, and Mr. W. Harris, lumberman.

Loud Lake, which I selected as the scene of my activity, lies in the forest about three miles from the nearest settlement. It is roughly a half mile in diameter, is fed by several brooks, and is drained by a stream that after lying sluggish for half a mile of still water, trickles through a mile of woods to the Bear River. There is no connection with any other lake except by way of the river. The nearest lake is another small one about a mile in a straight line to the north.

There was a small beaver dam where the lake entered the still water and a larger one at the lower end of the still water. On the lake shore was a brush heap that seemed to be a house under construction. In the still water there were two houses, but only one was in good repair and showed any signs of having been recently occupied. Close to the large dam were two brush heaps.

The colony nearest to the one that I studied was in the little lake north of Loud Lake. I did not see this but was told about it. The colony most available by water was about four miles away up the Bear River. My tents were on a little ridge some fifty yards from the lake shore on the west side. Two pens, 18 feet by 5 feet were set up on the beach below and jutted into the lake. During the whole summer I was the only person camping in the vicinity and the lake was undisturbed except for myself and those who came to see me.

In the course of time I caught one adult, a yearling, and two kittens, and I have good reason to believe that this was the population of the lake and stillwater. Early in the summer one of the kittens and the yearling escaped. Shortly afterward I caught a yearling and a kitten and feel confident that I recaptured the same animals. In the rest of this paper I shall assume this to be correct and describe the adult, the yearling and the recaught kitten.

Tony, the yearling of unknown sex, was my first prize. I caught him on July 8. He had apparently hurt his mouth by working on the wire

of the trap before I found him. In spite of this he spent a good deal of his time butting the wire of trap and pen. Occasionally he hissed at me, but for the most part he was rather indifferent to my presence. For three days he ate nothing, and then, his mouth seemingly better, he developed a hearty appetite.

The kitten, Paddy, was caught on July 27. It was of course impossible to tell his sex. He showed neither Tony's indifference to my presence, nor his persistence in working at the trap and pen. At my first approach he came hissing toward me, but this seemed pure bluff for he showed no more real intention of biting than had Tony. Before the day was over he had eaten from my hand. However, he never became quite as tame as did Tony. Both the young ones are treated as males.

Boadecia, the adult, had been in the habit all through August of coming to the camp at night and taking some of the poplar that I had cut to feed my captive beavers and which was stacked in the lake to keep it fresh. She weighed 41 pounds and was, as far as I was able to judge, a female. I had some difficulty in catching her for she avoided my Biological Survey trap and three corral traps which I built on the shore of the stillwater. For a good many weeks she remained out of a corral trap which I built just below the camp and into which I put all the cut poplar. On August 26, however, she gave way to temptation and got caught. In the trap she put up a desperate fight that will be described later.

FEAR

It might appear that a comparison of the varying length of time it took the beavers to become tame enough to let me handle them would be a good criterion of their relative timidity, but such was not the case.

In the first place, it is hard to distinguish between fear and dislike which may persist after most of the fear is gone. Two days after Tony's capture I caught him and held him on my lap for the greater part of an hour. At first his heart raced wildly, and then he grew gradually calmer, but his attitude toward me became more and more warlike. On September 13, I was blocking up the entrance to his sod house so that he would have to remain out in the daylight to be photographed. I had done this before several times. While I was working he came up close to the bank and hissed and hissed in an extremely loud and peevish fashion. He did not seem afraid of me, but did appear to dislike me for what I was doing.

Secondly, the situation is complicated by the fact that the beaver, underneath his calm and phlegmatic exterior, seems to be a very temperamental animal. On a certain night Tony and Paddy would be quite wild and not let me come near them, and the next night they would be up on the bank as soon as I came with the evening meal, climb over me to get the food, and show no signs of irritation when I

scratched their backs. The same arbitrary nature showed in their selection of food. At one time they would eat water lily pads and refuse the stems, and at another they would devour the stems but leave the pads.

Thirdly, it was impossible that each beaver should have exactly the same treatment and opportunity of losing his fear. Therefore, instead of describing their relative timidity, I shall list the varieties of things which seemed to frighten them.

A croaking frog caused Tony to start nervously on his first night in captivity. It was an interesting indication of his disturbed state of mind that such a familiar sound could so upset him. In those early days the sound of chopping at the camp also made him jump. Sometimes he did not dive but went on with whatever he was doing. Often he would step on the edge of his dish, and, when it tilted up, jump back. On July 12, at night, I was watching him sitting on the bank. There came a distant peal of thunder and he went leisurely into the water, but did not dive. After Tony had become fairly accustomed to me, strangers near the pen usually made him fearful. On such occasions he would often refuse to come in and take food from my hand, or would delay a long time. The same was true of Paddy, who was always kept with Tony. They were both upset by the smell and possibly the sight of a raccoon one morning and remained out in the water for more than an hour. When Tony had become familiar with the sounds about the camp, so that voices, rattling of dishes, or chopping caused him to give no signs of alarm, small sounds like the snapping of a twig would make him dive. It was my custom almost every night to feed him rolled oats out of my hand. After this I would climb out of the pen and he would sit calmly on the bank. However, as soon as my footsteps sounded on the ground, and despite the fact that he could plainly see me, he would take to the water and dive. He behaved in a similar manner when I approached the pen. As far as I was able to observe, he never got over this up to the time I left him at the beginning of October. Once or twice I managed to keep him from diving as I approached by speaking to him before I left the camp on the bank above, and keeping this up till I had reached the pen. It seems probable that this sort of fear would be very useful in protecting the animal against the approach of his common enemies.

Tail slapping is without doubt correlated with the emotion of fear, but I am not so sure that it is exclusively a danger signal as is commonly supposed. Often the wild beaver (Boadecia?) who came to steal the poplar would splash with her tail near the pen. The first two times this occurred Tony ignored it. Once on a later occasion he was on the bank, and after standing a moment went into the water, but did not dive. On another night he did dive. Twice more I observed him pay no attention to it. At the end of August I went to the Provincial exhibition at Halfax, and remained after hours one night to watch five beavers that were in an enclosure in one of the buildings. One, a kitten, swam about in a tank, frequently slapping the water and diving, apparently annoyed by my presence. Occasionally one of the other beavers dived with him, but in the main they ignored him. Dr. Dice, in his notes on the mammals of Alaska in Volume 2, No. 1, of the *Journal of Mammalogy*, also says that he has observed beaver not taking alarm at the tail slaps of other beaver.

Of course, it would be an error to come to any definite conclusions based on observations, such as mine, which were made on animals subject to these very artificial conditions. However, I suggest that as well as having some function as

a signal, the slapping of the tail may be important in startling and temporarily upsetting an approaching enemy. Boadecia when angry slapped her tail repeatedly on the ground. In the water in the pens Tony only once slapped his tail. Paddy did it a few times, and Boadecia did so whenever she was disturbed.

Tony and Boadecia reacted to anything that frightened them by rushing into the water and diving. Paddy also sometimes did this, but just as frequently he ran into the house.

The excretion of castor and drooling seemed to accompany the state of fear. Tony excreted much castor when I first picked him up. On August 23 I took Paddy out of the pen and brought him a little distance to take some moving pictures of him. I had him away something over an hour. This whole process seemed to disturb him very much. He drooled considerably and excreted castor. Taking him out for the same purpose on August 29 I noticed the drooling, but not the castor. The day after Boadecia was caught I smelled castor quite strongly in the pen. Later, during transportation to Waverly, a sanctuary near Halifax, I saw her drool. There were times, however, when I took Paddy out and did not notice the castor or the drooling.

I found the things that the beavers did not fear more surprising than those that they did. Although thunder seemed to annoy Tony, lightning did not. After he grew tame enough to come out on the bank and eat while I was close by, he would sometimes hesitate as if disturbed by sounds in the woods or at the camp. On such occasions, if I spoke to him, he would go on eating as though reassured by the sound of my voice. On the night of July 30, in the sod house, I saw a white-footed mouse run within a few inches of Tony's nose several times but the beaver paid no attention to it. On September 13 Tony and Paddy were sitting on the bank when a hawk (a marsh hawk, I think) called in the sky. I could not see that they took the slightest notice of the bird. Dugmore, in his "Romance of the Beaver," mentions the young beaver in Newfoundland running away at the sight of a hawk in the sky. The beaver at Halifax had been in captivity about a week when I watched them, and it is quite possible they had time to become used to their surroundings. Neither fireworks outside the building nor the barking of foxes in cages that almost surrounded the beaver pen, disturbed their feeding. On October 2 I turned Boadecia over to the authorities of Waverly Park, near Halifax. She was placed temporarily in a pen that usually housed bears, the bears being away for a week at an exhibition. Within the enclosure was a rocky den. Boadecia took refuge in this and did not in the least seem to mind the odor of bear which must have been particularly concentrated there, even if a week old.

RAGE

All the beavers made a sound when frightened or displeased that I have called a hiss. It was produced in the nose, both when the air was being inhaled and exhaled. However, they rarely showed what might be called rage. Boadecia gave two demonstrations of violent temper and Tony two lesser ones. In each case the provocation was great and the rise of anger so slow as to be of little use to the animal in anything but a quarrel with another beaver.

Boadecia's first outburst was when caught. I was not at the camp myself, but Bill Harris, who acted as my assistant, made the capture and wrote a description

of it at the time. Mr. Harris discovered the beaver at 3:30 A.M. I believe it best to give the account in his own words.

"She was putting up a big fight to get out and had been digging at the lake end of the trap on the left side of the door. She had a hole she could drive her head under, but her body was too big. She was very cross and showed fight as soon as I stepped up to the trap. I took some boards and drove them into the mud with an axe on the inside of the wire where she had been digging. She took the boards in her teeth and paws, pulled them up and threw them to one side. Then I drove them in on the outside and ran for a box. When I got back she was digging a new place. I lowered the box in, but she would not have it in there. She stood up on her hind legs and stopped the box from going on the ground with her front feet and head and started pitching it about the pen. I could not do a thing with the box. I stood on guard until daylight and then I went to the tents and got a rope. I tried to lasso her but she caught it with her hands every time. I threw a short stick at her, and she caught it in her hands and sat up and began chewing it. I managed to get the lasso over her shoulders and then I tossed a half hitch and got her again in the same place. I pulled her up the wire and got her by the hind feet and the back of the neck, carried her to the pen and turned her loose. She made a bolt for the water and struck the wire with such force that she turned over backwards. She did this a couple of times and then began swimming about." It is worth noting that as soon as the beaver was seized she gave up.

The second outburst came when on the morning of October 2 we boxed her up for shipment to Waverly. To catch her, we threw a net over her, but she tore it off as fast as we could put it on. She was not very quick in the struggle, or Mr. Harris and I would have been badly bitten. Once, when he caught her by a hind leg, she doubled toward him; he let go, and she sank her teeth into her own knee. On reaching Waverly she was turned out in a pen, and four of us set about making sure of her sex. She resisted and fought off fox tongs. When we approached she hissed and slapped the ground with her tail. Frequently she charged, hopping with both hind feet together. She was stiff and compact like a bullet, neck pulled in and legs drawn up close to her body. Saliva dribbled down her chin. Her fighting was not continuous, but concentrated in sudden unexpected dashes. Frequently she caught one man by the leg of his overalls, and at one time she was extended and lifted off the ground because she held desperately to the overalls with her teeth while someone pulled her tail. Once when a man caught her by the tail, she turned on him, but bit the tail so that it bled. At last we got a rope around her tail and lifted her off the ground. While one of us kept her attention by stroking her nose with a stick, the rest made the examination. The result was a little doubtful, but I think that I am justified in calling her a female. She was transferred to the bear den and went to a far corner, away from us. My camera in its case was lying on the ground about the middle of the enclosure. She shuffled toward it, not directly, but in a sidelong manner. I suspected nothing. When about two feet from it she suddenly pounced, bit it hard, and worried it to and fro as a terrier would a rat. An hour later when I went near the pen, she was at the other side. She came slowly toward me until about two feet from the wire and then leaped at it and wrenched it from side to side. After that she backed off slowly to the middle of the pen. Shortly after she went into the bear den and did not reappear until the next day, when she had to be smoked out. None of the

oats or apples put into the pen for the night were touched. I was told by Captain James, who is in charge of the animals at Waverly, that after he and his men got the beaver out of the den they tried to drive her some fifty yards toward a stream which they wished her to inhabit. They were forced to let her take her own course, since she not only refused to be turned aside by the men, but if any came near her she turned and charged. She entered the brook near the mouth and went down to the lake instead of up as they had wished. She swam away on the surface very quickly.

On one other occasion she showed a little flare of temper by seizing and tearing down an old shoe that had been hung at one end of the pen to frighten her away from working at the wire there. I did not see this, but was told about it by Mr. Harris.

On July 29 Tony was recaptured, and when I stepped into the corral trap, he hissed, caught my leg in his forepaws, and put his mouth against it as if to bite, but did not. I stroked him and presently he stopped hissing. Picking him up under the arms, I dropped him into the pen. While he was in the air, he wriggled and bit my thumb slightly.

On October 6 I took Tony and Paddy to Waverly. There was no difficulty about getting them into the traveling box. I simply turned it on its side and guided Tony in and picked Paddy up and put him in. As there was no place to put the beavers during their first night at Waverly, they had to remain in the box. Despite this, they ate well. In the morning I turned them out in a pheasant pen. Paddy ran away from me, but Tony, when I approached him, charged.

CURIOSITY

I found the beavers easily attracted and held by a jacklight. It may be that this strange fascination that the light has for them is partly or altogether due to curiosity. Several times when I was out on the lake with a flashlight a large wild beaver (probably Boadecia, since this was before her capture) followed my canoe, a quarter of a mile or more. On the night of September 9, I accidently dropped a handkerchief near the wire on the outside of Tony's pen. Tony saw it and came over to the wire. After a minute or more of poking with his nose against the fencing, he reached one paw through and pulled the handkerchief toward him. He took it by the hem in both paws at one corner, lifted it to his nose, set it down and turned away.

INDIFFERENCE

Besides their indifference to other animals, including myself, all the beavers were amazingly oblivious to leaves and sticks that clung to their faces, sometimes even covering an eye. I have seen them swim about for some seconds all plastered over when a stroke with one paw would have removed the encumbrances. The same was true of the beavers observed at the Halifax exhibition.

PERSISTENCE

As far as I was able to observe Tony after recovering from the shock of his capture on July 8 never passed a night between that date and October 6 without working on the wire of his pen at the lake end. He did not work for more than

several minutes at a time. I never saw him do it on land except during the first day that he was a prisoner. After his mouth became well, he used his teeth continually on the wire. Usually he caught the strands in his teeth and forepaws and worked them in and out. In this manner he often succeeded in breaking strands. The wire was No. 15, inch and a half fox mesh. Boadecia was not such a steady worker as Tony. Many nights would pass in which she apparently did nothing, but then suddenly one morning we would notice a large hole in the inner wire and frequently it would be big enough to permit her escape had it not been for the outer guard wire. Her method consisted chiefly in catching the wire and surging back with it. These outbursts of energy occurred at intervals until she was taken away at the beginning of October. It will be remembered that these sudden flares of activity with periods of calm between were also characteristic of her fighting.

Paddy paid less attention to the wire than did the other two, but frequently he came and worked beside Tony. He sometimes attempted to nibble the wire, a thing that I did not see the other two do. Once, many weeks after capture I saw him work at the wire when on land.

Early on the morning of August 31, I put some pickerel weed and water lilies into the pen of Tony and Paddy. Since I wanted a photograph of them eating, it was necessary to keep the beavers away from the food until after the sun was well up in the sky. For this purpose a friend stood on the bank and frightened them away when they came to the shore. I supported myself on the wire at the lake end of the pen and hence the beavers were between us. They had not had much food during the night. In spite of having a stick shaken at him and having the water stirred up, Paddy came in again and again. At length he had to be poked with the stick to keep him away. Notwithstanding all efforts he managed to get some of the leaves. Most of the time Tony crouched at the lake end of the pen, but after a short while he seemed to decide that he wanted some of the plants, and then became even more persistent than Paddy.

From these observations it seems likely that the persistence that the beaver shows in the matter of dam repairing is applied to other problems of his life. I point this out because there are some who believe that the beaver is little more than a dam-building machine and that the apparent mental qualities that he exhibits there do not apply elsewhere. However, I have no wish to push this thought further or claim that there is any analogy between persistence and "intelligence."

HABITS

All the beavers frequently chattered the teeth like muskrats, but more slowly. They did it most often before and while eating, but occasionally when angry. It seemed to be a sharpening process.

Paddy often rode on Tony's back when the latter was swimming.

Tony early formed the habit of working on the wire in the general vicinity of the southeast corner of the pen—the one nearest the stillwater end of the lake. Occasionally he worked on the northeast corner. Paddy usually worked where Tony worked until Boadecia was put into the next pen. After that he generally worked all along the side nearest the other enclosure.

Paddy spent much more time on land than did either Boadecia or Tony, and

when frightened very often ran into the house instead of diving into the water as they did.

Tony had a mannerism of stroking his chin with his right forepaw. This was a natural enough gesture when there was something on the chin such as rolled oats, but he would do it when there was nothing there, and frequently make the gesture without letting his paw touch his chin at all. Often, when on the shore, he would stop eating or walking as if disturbed by some distant sound, and while apparently listening make this motion like a nervous person.

Long observation of Tony convinced me that he was slightly left handed. Paddy and Boadecia seemed to be ambidextrous. I made a little test by placing oats on the outside of the pen close to the wire. Tony always reached with his left hand. I tried him on two different nights and he did it many times on each occasion. I tried Paddy and Boadecia only once. Paddy used both hands at the same time. Boadecia used neither, but tried to reach with her mouth.

The three beavers seemed to spend most of the night brushing themselves, when they were not eating or working at the wire. Paddy appeared to devote more of his time to this than did the other two. Frequently he and Tony would nip each other's fur.

On August 2, the day that I recaught Paddy, I had him in a wire enclosure near the tents. Three of us were standing outside the pen watching him. He had eaten one or two water lilies and registered disapproval of us by hissing and walking up and down looking for a place to escape. All at once he began to hiss and walk backward until his tail was under him and then he sat upon it, squeezed at the sides of his cloaca with his forepaws, bent down his face and made the sounds and motions of eating. I moved cautiously about but was unable to see just what he was doing, for his head blocked my view. One of the others, however, who was able to see from the side, said that some sort of thick liquid was excreted and that an organ was projected through the opening. I had seen two such horn-like organs when I turned Paddy over on first catching him. After a few seconds the beaver stopped, wiped his face with his forepaws, and began brushing. After that time I saw Paddy do this mysterious thing often, and also Tony, Boadecia, and some of the beavers at the exhibition in Halifax. I think that an investigation into the reason of this habit and its significance might be very worth while, and might perhaps shed some light on the function of the castor and oil glands.

A long pause that seemed to be due to deliberation and then sudden, almost unexpected, action was characteristic of all three beavers. In the early days of their captivity, they were naturally fearful of coming close to me to receive their food. They would swim back and forth, come near and then go away, and then all at once come straight in and take what they desired with scarcely any sign of hesitation. This was in contrast to the behavior of other wild animals that I have seen in similar situations. Usually they edge nearer and nearer with many retreats in between until they are just able to reach the food. On September 6, in the morning, I had the entrance of Boadecia's house blocked up for the sake of photography. She came out of the water and after a little wandering about the top of the house, returned to the water. Then followed some swimming about with one or two more inspections of the shore. For some minutes she remained quiet, with only her head over the surface. Then she went ashore to the blocked entrance, stood on her hind legs, returned to the water, hissed, went ashore again

and scrambled up onto the house above the door, thrust her nose and forepaws into a small hole that I had not seen, made it large enough to allow her body to pass and squeezed down into the house. She went so directly to this spot that it appears to me she must have discovered it during her seemingly aimless wandering on the top of the house.

This characteristic might make the beaver seem more stupid than he is, and perhaps is responsible for the low opinion of his mentality that some observers hold. I have been unable to form even the roughest sort of guess as to the extent and nature of the beaver's "intelligence."

IMITATION

When Paddy was first caught he was kept by himself for a few days. He worked at the wire in the northeast part of the pen. When Tony, after his recapture, was put into the same pen he went to his old southeast corner and began working on the wire by pushing and pulling. After a few minutes Paddy went to the same corner and attacked the wire in the same manner. Previously he had merely nibbled at the strands. On one occasion when I was observing the beavers I saw Tony come ashore and begin brushing. Paddy was already on the bank eating, but he stopped and began brushing too. This was not very significant for Paddy had been brushing at intervals all the evening. Tony went into the house and Paddy followed. I lifted a sod and looked in with the aid of a flashlight. Both were sitting at attention, one on each side of the chamber, puzzling, I suppose, about the light, and listening. After a second or two Tony began brushing and at once the little one did so too.

In general, Paddy went where Tony went and more or less did what Tony did, but there were some outstanding exceptions to this behavior. For example, Paddy often ran into the house when frightened, and spent more of his time on the bank than did Tony. Toward the end of September Paddy seemed to become more independent of Tony, and frequently the two would come out of the house in the evening at different times.

I think there is a suggestion here for some very significant work. If one were to investigate thoroughly the quality and quantity of imitation in the beaver, some conclusions might be reached concerning leadership among these animals and perhaps some explanation of how a group of individuals come to agree on a site for the dam, house, or canal.

SUMMARY

The following conclusions are intended to apply only to the beavers studied, but they may have some general significance.

A kitten, a yearling, and an adult were observed, making thus a series that well represented different stages of development. All three showed marked individuality, but no more than might be expected from the higher rodents in general. This was also true of their curiosity and tendency to imitate.

They were particularly afraid of small noises and the sound of footsteps and never managed to inhibit this fear. Their indifference to many things that would have frightened most other animals was surprising. Drooling and the excretion of castor accompanied the state of fear or excitement. It is suggested that tail slapping, which is correlated with alarm, may have less function as a signal than

is commonly supposed, and may possibly have value as a means of startling an approaching enemy.

The behavior of all the beavers was very inconsistent and arbitrary. Temper was slow to develop, but violent and quite confused when roused. They often bluffed by pretending that they were going to bite, but stopped before doing so. In the matter of persistence, one animal lived up to the beaver's proverbial reputation.

They all had what might be called a delayed response which, coupled with their habitual calm, was most deceiving. This is a point of which those attempting experimental work must beware.

One beaver had a nervous type of mannerism that consisted in stroking his chin with his right paw. He was left-handed in general.

All the beavers were seen to bite in the region of the cloaca. This has possibly some connection with the use of the castor glands.

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SOME HABITS OF THE POCKET GOPHER, GEOMYS BREVICEPS BREVICEPS

By Pennoyer F. English

[*Plates 9–10*]

This paper is a result of a study of *Geomys breviceps breviceps*, made during the period 1922–1931, while the writer was associated with the Department of Biology, at the Agricultural and Mechanical College of Texas, College Station, Brazos County. It is hoped that it may assist in solving the problems associated with economic loss. The territory covered by this study was within a radius of 20 miles of the college where, for the most part, the soil was quite sandy in nature.

Many field workers have pointed out that definite knowledge of the habits of animals is necessary in order that their management and control may be intelligently attempted. The importance of such knowledge is well illustrated by the work of Wight (15) on the pocket gopher in Oregon. He demonstrated through field investigation that carrots, which had for years been used as the principal bait for *Thomomys bulbivorus*, were actually cached and seldom eaten; that the amount of bait used for *Thomomys quadratus quadratus* (18) should be increased during the spring period; and that the usual method of checking poisoning efficiency by opening the runways would not hold for this species

during the spring because of the more or less gregarious habit of the animals at that season.

DISTRIBUTION, GENERAL HABITS, AND ABUNDANCE

Geomys breviceps breviceps is generally distributed throughout western Louisiana, southwestern Arkansas, and eastern Texas, in the river valleys, plains, and rolling lands. Its greatest damage is within the cultivated regions and horticultural belt where it injures certain crops and trees, especially the pecan. These habits differ, as we shall see, from those of the pocket gophers thus far studied. Being subterranean and for the most part nocturnal, the animals necessarily live in passages and burrows that they construct in the ground. The burrows on the whole are not very deeply placed, most of them being found at depths of between six and eight inches, though occasionally some are as much as ten inches below the surface. Where the large nesting mounds are constructed and much dirt is needed, the gophers dig deeper into the soil. The building of these large mounds is one of the principal points of difference between the activities of this species and those of the other pocket gophers that have been studied. Scheffer (13) reports that *Geomys bursarius* in Kansas usually lives in burrows made at depths of less than a foot, but sometimes in deeper placed passages. The nests are situated one and a half to two and a half feet underground. Wight (15) found that *Thomomys bulbivorus* of western Oregon lives in burrows made at depths varying from three inches to three feet and that the nests were placed quite deep in the ground; he also found (18) that *Thomomys quadratus quadratus* of eastern Oregon builds two types of runways, a surface runway just under the dust mulch for summer use, and a deep runway sometimes at a depth of four or five feet, with the nest at this or a greater depth and connected to the surface runways by a vertical shaft.

Geomys breviceps breviceps differs from other species in that it builds its nest not deep in the ground but in an enormous mound (Plate 9, fig. 1). Sometimes these mounds have a diameter of six feet and are heaped up 12 to 24 inches above the surrounding ground level. The mound illustrated, and many others, were dissected. The photograph illustrates a typical condition. Plate 9, fig. 2 shows a series of tunnels, three inches in diameter, and a store of freshly-cut food. In constructing their nests in these mounds the gophers gain the advantage of having their nesting and living quarters well above the surroundings so that neither temporary floods of a few inches of water nor wet conditions in the winter will interfere with their comfort. Food, in many cases, is stored in the mound, and these stores sometimes reach enormous proportions. A typical store found in one of the mounds is shown on Plate 10, fig. 1. In two separate stores were 175 nut-grass bulbs, one *Notoscordium* bulb, 2, 287 Bermuda grass cuttings, and the metal ends of two 12-gauge shotgun shells. The nest may be in close proximity to the stored food or much lower, depending on weather conditions. If the season is rainy the nest will be high in the mound, whereas in a dry season it may be beneath the mound at a depth of a foot below the original surface of the ground (Plate 10, fig. 2). The general rule is to build the nests in the high mounds. In order to obtain materials for these enormous mounds these busy little rodents make a series of excavations ramifying in all directions under the mound. When finished, the mounds may readily be seen at a distance of several hundred yards.

These animals are cleanly in their habits and deposit dung in special lateral tunnels leading out from the living quarters. As these tunnels are filled they are plugged. Often three such tunnels, and on one occasion four, were found filled.

Food is sometimes stored in hollowed places a short distance away from the nest but for the most part it is placed in or near the mounds. Lateral tunnels for general feeding branch out in many directions; and it is during these excavations while in search of food that the animals do considerable damage to cultivated crops. Should one of these animals start work on a golf course fairway he can cause much damage in a short time.

Weights and measurements of Geomys breviceps breviceps

LOCALITY	DATE COLLECTED	NUMBER COLLECTED		AVERAGE WEIGHT IN GRAMS		AVERAGE MEASUREMENTS IN MILLIMETERS					
						Total length		Tail		Tarsus	
		Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Bryan, College Station, Jones, and Pitts Bridge, Texas	1922	9	5	118.8	176.4	212.0	241.6	57.6	68.2	26.2	28.6
	1923	2	21	116.0	162.7	207.0	230.2	58.7	64.0	26.0	28.1
	1924	4	1	153.0	166.0	225.0	225.0	57.0	56.0	26.0	28.0
	1927	10	5	109.8	153.2	210.0	223.5	55.0	60.5	28.5	26.0
	1928	7	8	125.8	149.8	212.7	226.0	58.1	60.7	25.4	28.0
	1929	1	2	113.0	212.0	120.0	232.0	64.0	60.0	25.0	25.0
	1930	4	1	122.5	186.0	215.2	245.0	61.2	75.0	25.0	27.0
	1931	23	20	115.6	154.1	205.7	221.0	59.4	60.6	24.7	26.3
Average				117.1	160.5	207.8	227.6	58.5	62.4	25.6	27.2

Second to the damage done by burrowing is that caused by feeding. The food is determined by the plants present near the nest, and includes a great variety of succulent roots, stems, and leaves. In the prairie regions where this investigation was conducted fifteen different kinds of plants were found stored in their caches:

Common name	*Scientific name*	*Times of occurrence*
Bermuda grass	*Capriola dactylon*	21
Nut grass	*Cyperus esculentus*	15
Crow-poison	*Notoscordium bivalve*	8
Bur clover	*Medicago denticulata*	7
Johnson grass	*Sorghum halepense*	4
Mullein	*Verbascum thapsus*	4
Plantain	*Plantago occidentalis*	3
Bull nettle (roots)	*Jatropha texana*	2
Pale dock	*Rumex altissimus*	2
Vetch	*Vicia leavenworthii*	2
Catbrier (tubers)	*Smilax bona-nox*	2

Black-jack oak (acorns)	*Quercus marylandica*	1
Sensitive pea	*Chamaecrista robusta*	1
Small ragweed	*Ambrosia artemisiaefolia*	1
Black-eyed-susan	*Rudbeckia bicolor*	1

This list is no doubt incomplete. Observations on which the list of food plants were based were made in pastures, cultivated fields, deserted or abandoned farm lands, and on the campus of the college. Pecan trees are frequently girdled or cut off completely. It has been estimated by Brison[1] that in isolated cases about 10 to 20 per cent of the pecan trees may either be killed outright or be so injured that removal is necessary. He also points out that in the sandy parts of Texas, where strawberries are customarily grown, the gopher is one of the most harmful of rodents, frequently destroying practically all the strawberry plants.

ENEMIES

The natural enemies of this rodent are few, including the king snake, *Lampropeltis getulus*, and such avian enemies as the great horned owl, or rarely a hawk, and an occasional mammal predator, such as the weasel and skunk.

A complete record of the external and internal parasites found during this study gives no evidence that these parasites (two external and two internal) are of sufficient importance to bring about natural control; they might, however, affect the animal's increase under conditions of heavier population. The roundworms occur in the stomach, while the tapeworms are in the small intestine. The kind and prevalence of these four parasites found in and on the 161 gophers examined is as follows:

Parasites of Geomys breviceps breviceps[2]

Specimens examined for parasites	161
With lice, *Trichodectes geomydis* Osborn	119
With mites, *Laelaps* sp	11
With roundworms, *Protospirura ascaroidea* Hall	23
With flatworms, *Hymenolepsis* sp	8

BREEDING HABITS

A definite knowledge of the breeding habits of pocket gophers is very difficult to obtain. Scheffer (12) found that pocket gophers in Kansas produce one litter a year, the number of young varying from three to six; later (12) he found that *Geomys bursarius* bears from one to six young, with an average of 4.2, and that *Thomomys douglasii yelmensis* of western Washington produces from two to seven young, with an average of five to the litter. Wight (15) found that the breeding period of *Thomomys bulbivorus* extends from March to July, and that one litter a year was produced, with an average of five young. Horn (8) found conclusive

[1] Letter from Professor F. R. Brison, Department of Horticulture, Agricultural and Mechanical College of Texas.

[2] The writer is indebted to Dr. E. W. Price for identification of the parasites, excepting the mites, which were identified by Dr. H. E. Ewing.

evidence that *Thomomys townsendii*, at Vale, Oregon, produces two litters a season in rapid succession. Another Oregon gopher, *Thomomys quadratus quadratus* was found by Wight (18) to produce two litters a year with an average of 6.5, some females having as many as nine foetuses.

In the case of the Texas gopher, *Geomys breviceps breviceps*, it was found by the writer that these animals were not nearly as prolific as those just mentioned. Examination of 25 females taken in Brazos Co., Texas, between March 7 and May 26, showed the number of embryos usually to be 2 or 3, rarely only one, the average being 2.36.

At College Station, young were born on April 13, 1922, and March 13, 1923; at Bryan, Texas, on April 29, 1923.

Summary of examinations

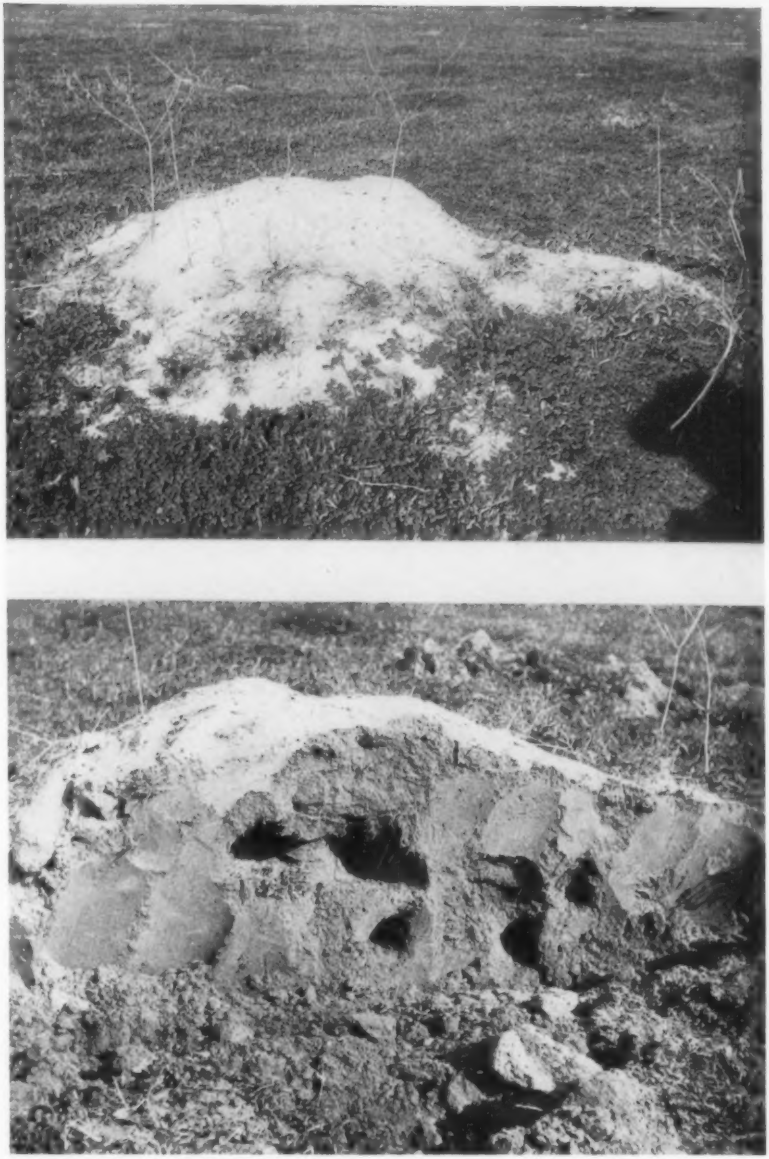
Female gophers with normal uterus	52
Females showing congested uterus	21
Females pregnant	21
Females with young born in nests	4
Total number of females examined	98
Total number of embryos	51
Total number of young born in nests	8
Average number in litter (data from 25 females)	2.36

An attempt was made to mate these gophers in captivity, to determine the gestation period, but under the enforced artificial conditions, mating did not occur. Neither in 1923 nor 1931, when the two sexes were placed together, was there any sign of mating. One pair was kept in captivity for an entire year. Although these animals all got along peaceably, males and females often living side by side in the same nests, while in other cases two nests were constructed in the same cage, no mating took place. In nature these animals are solitary in habit, and on only two occasions were more than one gopher found in the same system of burrows. In October, 1927, a male and female were trapped in the same burrows, and in March, 1931, two females were found in the same tunnel.

On three occasions in the spring gophers were observed crossing a highway at night. The young are produced at different periods during the spring months. The period of reproduction varies considerably and extends from early in March to late in May. The period in which the young are born varies from March to July. Information herein presented shows that only one litter a year is produced.

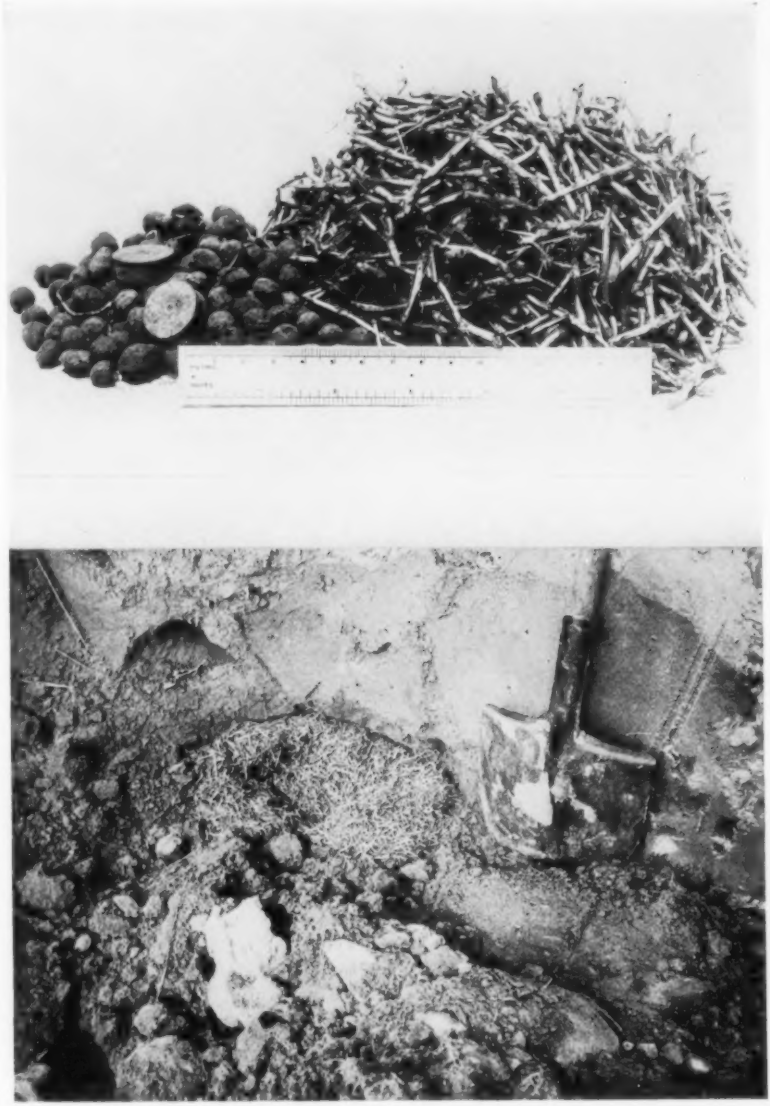
These animals in captivity have the habit of sleeping soundly. On more than one occasion the nests have been torn open and the sleeping animal picked up and laid on a table without awaking it. On one occasion the gopher did not awaken for more than three minutes.

It may be of interest to note here that Dr. J. C. Cross (4) in his work at the University of Texas used some of these gophers in his cytological studies and found upon enumerating chromosomes a tentative number of 84 diploid for this species.



UPPER.—A TYPICAL LARGE RESIDENCE MOUND OF GEOMYS BREVICEPS BREVICEPS
LOWER.—MOUND SHOWN ABOVE DISSECTED VERTICALLY, SHOWING TUNNELS

UNIV. OF MICH.



UPPER.—A TYPICAL FOOD STORE OF GEOMYS BREVICEPS BREVICEPS
LOWER.—FURTHER DISSECTION OF MOUND SHOWN IN PLATE 9, SHOWING DEEP NEST

UNIV. OF MICH.

From these data it is evident that the males were larger than the females and that the females outnumbered the males, 98 to 63, a sex ratio of 0.61.

SUMMARY

1. Trapping, field, and laboratory observations were made on *Geomys breviceps breviceps*, chiefly near College Station, Texas.
2. The active season for these animals seems to be throughout the year.
3. The breeding season begins in January or February and lasts through July.
4. Only one litter a year is produced.
5. The majority of the young are born in March, April, and May.
6. The average number in the litter is 2.36. In no case were more than three foetuses found.
7. The animals are apparently solitary in habits, uniting in the burrows in the spring for mating purposes.
8. Many females are not mated, no doubt because of scarcity of males.
9. No definite information was obtained on the length of the gestation period.
10. The animals are easily kept in captivity and easily tamed.

LITERATURE CITED

(1) Bailey, V. 1915. Revision of the pocket gophers of the genus *Thomomys* U. S. Dept. Agric., North Amer. Fauna, no. 39, 136 pp., illus.
(2) Breckenridge, W. J. 1929. Actions of the pocket gopher (*Geomys bursarius*). Journ. Mammalogy, vol. 10, pp. 336–339, illus.
(3) Criddle, S. 1930. The prairie pocket gopher, *Thomomys talpoides rufescens*. Journ. Mammalogy, vol. 11, pp. 265–280, illus.
(4) Cross, J. C. 1931. A comparative study of the chromosomes of rodents, Journ. Morphology, vol. 52, no. 2, pp. 373–401.
(5) English, Pennoyer F. 1923. The dusky-footed wood rat (*Neotoma fuscipes*). Journ. Mammalogy, vol. 4, pp. 1–9, illus.
(6) Grinnell, J. 1923. The burrowing rodents of California as agents in soil formation. Journ. Mammalogy, vol. 4, pp. 137–149, illus.
(7) Howell, A. Brazier. 1922. Surface wanderings of fossorial mammals. Journ. Mammalogy, vol. 3, pp. 19–22.
(8) Horn, E. E. 1923. Some notes concerning the breeding habits of *Thomomys townsendi*, observed near Vale, Malheur County, Oregon, during the spring of 1921. Journ. Mammalogy, vol. 4, pp. 37–39, illus.
(9) Johnson, C. E. 1926. Notes on a pocket gopher in captivity. Journ. Mammalogy, vol. 7, pp. 35–37.
(10) Merriam, C. H. 1895. Monographic revision of the pocket gophers, family *Geomyidae* (exclusive of the species of *Thomomys*). U. S. Dept. Agric., North Amer. Fauna no. 8, 258 pp., illus.
(11) Miller, G. S., Jr. 1924. List. of North American Recent Mammals. U. S. Nat. Mus. Bull. 128, 673 pp.
(12) Scheffer, T. H. 1910. The pocket gopher. Kansas State Agric. College Exper. Station Bull. 172, 39 pp., illus.
(13) ———1931. Habits and economic status of the pocket gophers. U. S. Dept. Agric. Tech. Bull. 224, pp. 1–26, illus.

(14) Wade, O. 1927. Food habits of a pocket gopher. Journ. Mammalogy, vol. 8, pp. 310–311.
(15) Wight, H. M. 1918. The life history and control of the pocket gopher in the Willamette Valley. Oregon Agric. Exper. Station Bull. 153, 55 pp., illus.
(16)———. 1920. Pocket gophers in Oregon. Oregon Countrymen, vol. 12, no. 7, p. 18.
(17)———. 1922. The Willamette Valley pocket gopher. Murrelet, vol. 3, pp. 6–8.
(18)———. 1930. Breeding habits and economic relations of the Dalles pocket gopher. Journ. Mammalogy, vol. 11, pp. 40–48.

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NOTES ON A FAMILY OF RED BATS IN CAPTIVITY

By Charles E. Johnson

The bats here referred to consisted of a female and three young *Lasiurus borealis borealis* that I found hanging from a branch in an Osage orange tree at Lawrence, Kansas, June 16, 1919. The young were approximately half grown.

In attempting to cut off the branch from which the bats were hanging I accidentally shook them loose. The parent fluttered downward with its burden but happened to catch on my belt, where it quickly adjusted itself, and I allowed it to hang thus while I walked to my house about half a mile distant. I proceeded at an ordinary pace, and although the furry ball received more or less jolting and kept flapping against my body, the mother bat made no attempt to release its hold and fly away.

On my arrival at the house the bat cluster was transferred to a small branch cut for the purpose, and photographed. Such handling as was necessary during this procedure produced no apparent uneasiness among the bats and they continued to sleep as if undisturbed. Having finished with these preliminaries I fastened the twig to the screen of an east-side porch, which was large enough to permit the bat to fly about but offered no chance of escape.

Later in the day I visited the bats from time to time and then noted that the parent was not supporting the entire weight of its family in addition to its own. Each of the three young ones, though clasping the parent with its wings, usually had one or both feet hooked over the

twig. From time to time they shifted the position of their feet, so that one might have both feet hooked over the twig, another might have one foot attached to the twig, the other hooked in the fur of the parent; the third might for the time being have no hold on the twig.

GENERAL OBSERVATIONS

At 6:50 P.M. the first evening the parent left its young hanging from the twig and began flying. It circled about on the porch, now at a higher and then at a lower level, until it had explored practically all levels of the air from ceiling to floor. It also flew about in the various rooms to which it had free access. At the start of the flight it was still light enough in the middle of the rooms for me to see to write my notes. Later, when the lights were turned on, the bat flew from room to room, upstairs as well as down, circling about many times in one room before going to the next. The screened-in upstairs and downstairs porches, where many tiny insects came in, were most frequently visited. Several times during the flights on the porches the bat lit on the floor, where it remained for a few seconds and then rose again as lightly as a bird. When it was upstairs it could quickly be drawn downstairs by turning off the lights upstairs and turning on those downstairs; likewise it could be induced to come in from the porches and to any desired room merely by turning off and on the proper lights. Little attention was paid to the members of the household moving about. Frequently the bat lit on the porch screens where it hung for about ten or fifteen seconds, chewing energetically food which it evidently had gathered during its flight. This accomplished, it immediately took wing again. A number of times while the bat was thus engaged in mastication I touched it and stroked it very gently with my hand without any show of fear or resentment on its part. It appeared wholly pre-occupied with chewing.

At 9:30 P.M. I moved the twig with young attached to a more conspicuous place on the porch screen, but the flying bat took no notice of them; neither did it show any interest a little later when it lit on the screen and I held the cluster of young up to its face. It merely flew off again to continue its feeding. However, a few minutes after this as I stood holding the young bats up against the screen, the parent suddenly lit close to my hand, and as I then moved the young up to its face there was instant recognition on the part of both mother and young. The latter, mouths open and all vibrant, scrambled onto the parent's body and each soon found a nipple. The family was then transferred to its former place on the screen.

The next morning I found the parent with its young where I had left them the evening before, and it was uncertain whether or not the bat had been flying since then.

The evening of June 17 the bat began flying at 7:50 P.M. This time I left them all undisturbed to see if the parent would be found with its young the next morning; but when morning came the bat was lying on the floor, apparently dead, though such was actually not the case. It responded but feebly when I picked it up, and its tongue and mouth lining were very pale. I held it up against the young ones which instantly woke up, clambered onto the mother and acted as though nearly famished. The mother responded feebly but convulsively. There-

upon I fed the bat a few drops of milk, diluted one-half with water, which was accepted freely. More of the liquid was given it during the day, and toward evening it appeared normal.

Early in the day I discovered that one of the young was missing from the family twig and after some search found it hanging from a wire close to the ceiling in the remotest corner of the porch. It was the only instance during the course of these observations when the bat had moved any of the young ones.

At about 8:00 P.M. on this evening (June 18) the bat started flying, but after an hour and a half of activity seemed to be preparing to hang up at a point remote from where its young had been left, and I therefore brought the family together, as previously. Again the same quick mutual recognition, and when all were securely attached to the twig I restored them to their customary place.

On the morning of June 19 the bat was hanging with its young, and again it was doubtful that it had been flying since I left it the evening before. When evening came it flew for a short period, at the end of which I restored it to its young and left it. The following morning it was hanging on the screen at some distance from its young.

In the evening of June 20 the bat for the first time accepted a few flies and some very small grasshoppers that I offered it. Such food had previously been rejected. On this evening the bat did not start flying until 9:00 P.M. Again I left the family to itself to see if the parent would be found with its young in the morning. But again it was found hanging some distance away from the young.

During the day of June 21 the bat was offered more insect food, and this time it ate greedily three very small grasshoppers, and a caterpillar about three-quarters of an inch long, which I cut up and fed to it piece by piece.

The young ones during all this time seemed to be in perfect health; they stretched their wings, yawned, washed themselves, licked their mother's face and, in short, acted in all respects as healthy young animals usually do.

In the evening of June 21 I found the bat chewing at the terminal segment of one of its fingers. It had already severed the bone and chewed out a part of the interdigital membrane. It continued to gnaw as I watched, and the crunching of the bone between its teeth was distinctly audible. It was highly irritable and snapped savagely at one of the young ones that tried to lick its mother's face. I offered it a grasshopper, which was devoured with seeming ferocity, exoskeleton and all. However, at 9:00 P.M. it dropped from its twig in the usual way to begin its evening flight; but because of its self-inflicted injury it could only flutter to the floor. After it had made a number of futile attempts to rise I placed it on the screen to climb about and perhaps feed on such insects as it there might find, and left it. The next morning I found it dead, attached to a broom onto which it had crawled.

Behavior toward the young.—A number of observations were made on the activities of the family just before the start of the evening flights of the bat. On the first evening all the bats were awake at this time, the parent busily engaged in licking the faces of the young. Its behavior was very similar to that of a cat toward its kittens. There was also much yawning and stretching on the part of all. I noted that the parent removed a number of droppings that had stuck to the fur of the young, and these droppings it chewed and swallowed.

The first evening and subsequently when the bat was about to start its flight

its first move was to disengage itself from the young ones. This was accomplished by more or less "hitching" of its body, a shifting of its feet on the twig and a drawing away from the young, causing these to release their hold. As previously remarked, the young ones during much of the time had at least one foot hooked over the twig, so that when the parent drew away from them they merely let go their wing hold on the mother and, after more or less readjustment among themselves, settled down clasped to one another.

When the parent had freed itself it dropped the distance of a foot or so to the screen, from which, after but a momentary pause, it launched into flight.

At this stage the young evidently were too heavy, collectively, for the parent to carry about in flight. As already stated, on the night of June 17 one of the young had been carried, but for an unknown period. Doubtless two of the offspring could have been carried at one time, and possibly all; I attempted no experiments in this connection. But since the parent on the first evening of its captivity left its young hanging on the twig, it is probable that these were, at this age, too much of a burden to carry. In the present instance I had no means of weighing the individual members of the family, but judged that the combined weight of the young exceeded the weight of the mother. On a later occasion, however, when I had secured another family of bats of the same species, I chanced to make an observation in line with the present question. In this family there were four young—three females and one male. While I was handling the group, the parent, with two of the young ones attached to its body, fell from my hand. The instant it dropped the bat spread its wings and fluttered downward, breaking the fall and striking the floor lightly. It then fluttered along the floor in an obvious effort to rise into the air, but did not succeed. The distance available in which to gain momentum was only about twelve or fourteen feet, and it is therefore quite possible that with a better start it might have been able to rise; and that if it had dropped from a greater height or had been tossed into the air it might have been able to sustain flight. One of the young that formed the load was the male; the other was one of the three young females, but a little later when I weighed the family I was unable to identify this particular individual. The maximal and minimal possibilities may, however, be stated. The three young females weighed, respectively, 7.27, 7.02 and 6.57 grams; the male weighed 5.70 and the parent 13.65 grams. Hence the combined weight of the two young that formed the load could not have been less than 12.27 nor more than 12.97 grams; in either case somewhat less than the weight of the parent itself. These bats had just been brought in from the field, and the parent may therefore be considered to have been in normal condition of health and strength.

Referring again to the first family it remains merely to state that an effort was made to rear the young by feeding them diluted milk. They accepted this readily enough, but seemed to weaken rapidly and died two days after the death of the parent.

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A PAIR OF LONG-TAILED SHREWS (SOREX CINEREUS CINEREUS) IN CAPTIVITY

By Philip M. Blossom

Although long-tailed shrews of the genus *Sorex* are often taken by collectors, there exists a surprising lack of data relative to their habits. These shrews are very rare in some localities and when present are seldom seen because of their secretive ways. They are not easily caught in the ordinary live traps, due to their diminutive size. When one is taken in a trap it is likely to be found dead, perhaps because of starvation or exposure. If an individual is found alive, is removed to the laboratory and given, as the observer believes, a natural and comfortable home, it is generally found dead within a few hours.

While trapping near Ann Arbor, Michigan, for meadow mice I observed that for two nights one of the "Delusion" traps had been entered and the bait of rolled oats removed. The third morning a small shrew was seen escaping from the inner compartment of the trap. By remodeling the trap I was able to capture two shrews *Sorex cinereus cinereus*, on April 28, 1930. The trap was rebaited and visited again at noon. One proved to be a male and the other a pregnant female.

The trapping station was a marshy lowland, like the characteristic shrew habitat as described by Jackson.[1] Food was apparently abundant, for many snails, worms and insects were to be found within close range.

The shrews were housed in individual cages, consisting of glass cylinders 10 inches in diameter and 9½ inches in depth. The bottoms were filled to a depth of approximately 2 inches with damp earth, on which was placed damp moss, dead grass, and dead leaves. A small nest-box was supplied to each cage. The earth and moss were sprinkled daily with water, and pans with water were placed about the room to increase the humidity percentage. It is believed that the success in keeping the shrews alive was in large part due to the moist atmosphere in which they were kept.

Long-tailed shrews of this group are apparently exceedingly high-strung and nervous, and very seldom are captive specimens seen reposing, or in any way resting themselves. Most of their energy is devoted to the endless search for food. Their actions are quick and jerky, with many sudden startings, turnings and stoppings. Even when the shrew

[1] Jackson, H. H. T. 1928. U. S. Dept. Agric., North American Fauna No. 51, p. 3.

is apparently resting its body, the snout and the head can be seen continually moving, as if the individual were searching the air for the scent of some favorite food, and in case such a scent is detected the animal immediately starts in pursuit.

DETAILED OBSERVATIONS

When the two shrews were first put together in a cage, they exhibited great nervousness and excitement. Rolled oats was given, and they began smelling about to locate the food. It was eaten with no hesitation or apparent fright. Ceaselessly they searched for a means of escape, first by digging into the sand and then by attempting to climb the sides. At one time the two in their excitement met in a corner. Each raised up on its hind legs in a defensive attitude and began to scold with rapid and excited, squeaking notes. The movements are at times so rapid that it is extremely difficult for the eye to follow them.

Much has been written on the sensitiveness of the long-tailed shrews to noises or shocks. Some authors have thought that the unsuccessful attempts to keep these shrews in captivity can be attributed to fright, or to restlessness and overactivity in the new environment. However, in the case of neither of the two specimens considered here was fright the cause of death, and both lived in captivity for a considerable time. The female lived 77 days, the male 13 days.

The two shrews were brought into the house and placed in a small room three feet from the side of the furnace, with only a thin partition between. The furnace was attended twice daily with the production of considerable noise, but if there was any harmful effect produced upon the animals it was not observed in their behaviour. To test the effect of noise upon them, I have given a sharp clap with the hands directly above their cage and there seemed to be no harmful result. On other occasions a sharp tapping on the glass cylinder failed to frighten them to any extent. At one time a dog, seeing the shrews in the cage, barked into the very top of it. The above experiments apparently produced little reaction in the animals, other than occasionally forcing them to seek cover. Another instance might be cited. The female was carried forty miles in an automobile, and finally taken through the center of Detroit, with the accompanying rattle of street cars and the loud blasts of automobile horns. She lived for many days following the experience.

The shrews have been heard to use three distinct types of vocal or other sounds. When angry or fighting, a rapid series of rather staccato squeaks can be heard. While eating or in search of food they uttered a succession of faint twittering notes. These notes are so very soft and are produced so rapidly that they give to the voice a quality intermediate between a purr and a soft twitter. At times a slow gritting of the teeth is heard. This would seem to be associated with inactivity, for this sound is frequently produced when the shrew is resting.

Resting periods are short. If the creature is gorged with food it will cease foraging for brief periods and either retire to the nest or sit on the soft moss or below the moss in one of its numerous runways. While resting on the surface the shrews usually busy themselves by cleaning the hair or scratching. A sitting position is assumed with the weight of the body thrown on the hind legs. The animals seemingly disregard the fact that they are in plain view and that some

danger might come to them. However, if a person enters the room or a slight noise is produced, they will quickly dart into hiding and not emerge until all noise has ceased. Having been frightened to shelter they present themselves again very slowly and in a cautious manner.

When the lights are turned on at night, the shrews are often found sleeping. The position assumed is with the head bent forward and under the body as far as possible. The appearance given is that of a small round ball of hair. When in this attitude the body-weight is thrown on the hind legs with the anterior part of the body slightly elevated.

The animals are often seen dozing during the day. While resting, the head is seen to lower, little by little, until the creature is apparently conscious of its drowsing, then with a quick jerk the head is raised. An inspection is made to see that no danger is about, and, when assured of this the dozing is resumed. I have seen the procedure repeated successively until finally the shrew, apparently rested, continued the search for food.

Sight evidently plays a considerable part in the life of *Sorex cinereus*. The eyes appear, upon gross examination, to be of nearly normal size in proportion to the small size of the body, and stand out as a prominent characteristic. The quick movements are well directed, and never is the animal seen to hesitate or grope about after the manner of *Blarina* when placed in the light. The animal seems aware at all times of its location, and when the individual is escaping or meets an obstacle its procedure is definite and directed. However, the range of vision must be confined to very short distances, for when movements are made a few feet from the subject there is no apparent reaction by the shrew.

It was doubtful, from observations of our captive shrews, whether the sense of smell is well developed. Although the nose is in continual use, as attested by the movement of skin and vibrissae, and the continual sniffing of the air, yet when food was offered, the animals would search for some time before locating it. When food was placed in the cage the shrews became unusually nervous, with increased activity in an effort to find the object. Some foods, such as insects or odorous meats, stimulated them to greatest activation, while rolled oats was capable of producing only a mild reaction. When the shrew had located the source of stimulation its entire attention was temporarily devoted to examining this food. It seems possible that at close range, the sense of smell may serve as a very effective means of locating food.

Hearing must be acute for certain sounds or tones. Various tones, sometimes almost imperceptible, will often cause great alarm. Loud noises, on the other hand, as noted above, are apt to produce no apparent reaction. If in nature the shrew will rest itself in plain view of enemies, as is the case in captivity, there must be an important need of well-developed organs of hearing, for the eyesight is undoubtedly limited to very close range. In life the prominence of the little ears is noticeable. These project from the head to such an extent that the head appears to be of a well-defined triangular shape.

The degree to which the sense of touch is developed was not ascertained. It is certain that the vibrissae are extremely sensitive and that they guide the animal materially in finding its way.

Shrews evidently indulge at times in certain forms of play. The male was once found pushing the lid of the nest-box up and down with the end of its nose, thus

producing a rattle against the tin box below. The lid was slowly worked back and forth across the box until it fell to the floor of the cage. Another form of playfulness was exhibited in the killing of an insect. A small insect was placed in the cage and the shrew at once attacked it. A terrific struggle was pretended, in which the insect was repeatedly attacked and thrown into the air, sometimes falling on the shrew, in which case the shrew would quickly jump to one side and cautiously watch its supposed adversary for a short time, when it would rush in for another assault. After a presumably hard fight the insect was killed and eaten.

When the two shrews were placed together there was at first a considerable amount of fighting and it was necessary to separate them into individual cages. However, when the male was placed with the female, after her young were born, they apparently did little fighting, for after eighteen hours together they appeared no worse for the meeting. Subsequently the two were often allowed to associate for the purpose of observation, and except for occasional squeakings at one another, were always congenial. I conclude that the pregnant female is antagonistic to the presence of a male, but that the non-pregnant female at least tolerates the company of her mate.

Observations on the captives showed that burrows were not made below the surface, but in a wild state the shrews undoubtedly use the burrows and tunnels made by other small animals. Earthworms placed in the cages would often escape by burrowing to the bottom of the soil, and although the shrews were hungry at the time they would make no attempt to secure them. However, if the animals could find a worm not entirely submerged, they would seize the projecting end and tug until the worm was either severed or pulled from its burrow. When searching for food the shrews would often investigate any small opening or crevice in the soil. Worm burrows were examined by placing the long snout in the entrance. If no food was within reach they would not waste time in an attempt to enlarge the hole, but would proceed to forage in other places. At no time were the animals observed to dig into the loamy soil for food. One instance, however, might be cited of their digging in loose sand. The pair were placed for a time in a large box containing fine, loose sand. No shelter from the bright sun was afforded in any part of the enclosure. They at once began to dig into the sand but with all their effort it was impossible for them to completely cover their bodies. However, they seemed content to have only the head covered. The action of the feet when digging was extremely rapid, with the hind feet moving backward and outward. The forefeet were moved straight toward the rear and parallel with the body. Digging in the sand was not an effort to obtain food, for as soon as the animal was well covered, it remained motionless for some time. The actions did not in any way resemble those employed in the obtaining of food.

Runways were formed in the foraging for food. Many runways were forced through the damp moss, or, where the moss came in contact with the cage, a well-worn tunnel would be made. Bits of food, such as dead insects and portions of worms, were always to be found distributed throughout the tunnel network. Any loose vegetation or object lying on the ground was repeatedly investigated by the shrew forcing its way underneath. Such places were often very productive of insects or worms.

Feces were deposited in any convenient place and not in chosen spots. On the

top of the moss was the most usual depository, for the animals performed most of their activity there. While eating, the shrew frequently leaves its food to run aside and drop the feces. It will hurriedly go a few steps away, but returns at once to its meal. Some time is spent each day in cleaning the hair. The mouth is used for most parts of the body. To clean the ears and back of the head the forefeet are utilized. The head is bowed forward and the feet brought up to stroke the hair on top.

A peculiarity is the scratching of the tail and hind parts. The hind foot is used by being doubled around to reach the most inaccessible parts of the body. The anus of the male was continually scratched in this manner. The movement of the foot is extremely rapid and unless the observer is close to the cage and of sharp vision he will see no motion.

On one occasion the shrews were placed in a sand-box, 5 feet square by 12 inches deep. Here the amount of activity was amazing for an animal of this size. They remained close to the sides of the box and made two or three complete circuits before stopping. When they did stop it was only for a brief rest, for they continued the running almost at once. When running they carried the tail straight to the rear, with a gradual upward curve toward its end. While in the sand-box they attempted to escape by jumping up the sides. It was estimated that from a stand the jump reached 4 or 5 inches, and with a short run 6 or more inches.

Glandular areas just posterior to the forelegs, and each measuring 3 millimeters in length, were found after death on the male.

Small mites were observed in the hair of the male after death. These were not identified.

FEEDING HABITS

When tearing at the flesh of an animal, the shrew placed one or both of the front feet against the food and voraciously seized the flesh with its teeth, pushing with its feet and viciously pulling and shaking with its head. The hind feet are well-supported under the creature and a tenacious tugging and tearing is resorted to until the flesh is torn loose. The shrew then relaxes its grip until the meat is chewed and swallowed. The eating of vegetable matter is quite different. The food is taken between the forefeet and lifted to the mouth, and the shrew sits back on its hind legs and nibbles, much as a mouse would do. Occasionally the food is picked up with the mouth without the use of the feet.

Eating is accompanied by a vigorous movement of the abdominal region, with a swaying from side to side of the posterior portion of the body. The swaying and movement of the abdomen is most pronounced while the animal is chewing and swallowing its food. While eating favorite foods the act is invariably accompanied by an almost continual series of the purr-like sounds previously described.

Earthworms are most generally killed at once upon being placed in the cage. They are then distributed in advantageous positions, usually on or in the damp moss, and are returned to later when the animal is in need of food. The worms may be left whole or cut into small pieces. Undoubtedly the worms are preserved and kept fresh by the moisture in the vegetation. Other foods, such as insects, are also deposited here, rather than on the earth of the cage.

When the two individuals were placed in a cage together they would often fight for any food that was captured, regardless of the finder's rights. In one instance there had been a long search for food when finally the male located a worm in the top of its burrow. The shrew put its nose into the hole as far as possible and emerged with one end of the worm in its mouth. After much tugging the worm was dislodged and carried to a corner, where the captor began to eat it. The female, having found no food, attacked the male and fought for possession of the worm. He attempted to eat and fight off the female at the same time. When necessary the male would leave his food to drive the other a greater distance away, but would hurriedly return to eat. The worm was finally consumed by the male and the two shrews resumed their searching.

When a live spotted salamander (*Ambystoma* sp.) was introduced into the cage, the shrew became much excited and ran about the cage frantically sniffing the air, as if to locate the scent. Finding the salamander, it attacked the head. After the first attack the shrew began to poke its nose into the ground, giving the impression the salamander had left a disagreeable taste in its mouth. However, another attack was made and after the third attempt the salamander was dead. The head was eaten first and then the viscera.

Occasionally dead meadow mice (*Microtus*) were offered. The parts about the base of the skull and the forelegs were eaten first. Next the brain case would be eaten through and the contents consumed. Not infrequently the posterior portion of the mouse was left untouched.

The wings, legs and other chitinous parts of insects were, so far as could be determined, never eaten.

Food experiments extending over eight days were conducted with the female. The cage was thoroughly cleaned at each observation, when fine, sifted dirt was renewed to a depth just covering the bottom, and a new food supply provided. Weighing of the food and cleaning of the cage was performed every twelve hours. At the end of a feeding period the shrew was removed from the cage and the contents of food separated into small dishes. The dirt was then thrown away and the food weighed. Earthworms were always soaked in water to remove any particles of dirt that might be adhering to them. They were then placed on an absorbent cloth to remove the water on the external surface. The weight of food eaten having been calculated, the new food was weighed (washed and dried when necessary) and placed in the clean cage. The shrew was weighed every twenty-four hours. During the twelve hour period there was undoubtedly a small natural loss of weight in the food by evaporation, although the humidity was high. The worms and some other foods were washed in water before being weighed.

Figures for seven days show the shrew to have had an average weight of 3.6 grams, and it ate an average daily weight of 11.7 grams; that is, it ate an average of approximately 3.3 times its own weight every twenty-four hours. A large number of earthworms were consumed, usually being preferred to a variety of other foods. Salamanders were eaten rather sparingly. A small amount of rolled oats was eaten every time it was given. Cutworms were tasted when proffered, and meadow mice were enjoyed. Small moths were offered twice and both times were eaten. Sowbugs were eaten when placed in the cage. Insect larvae were relished, and grasshoppers, beetles, spiders, centipedes, and hellgra-

mites were much enjoyed. Hamburger steak was eaten once, and liver when offered. Snails were given three times and eaten twice. Perch was a delicacy. Frogs, slugs, carrots, and apples were never eaten.

Hamilton[2] finds that in this species "Worms, as with *Blarina*, form a very small part of the diet." Jackson[3] says, "Shrews are known to eat earthworms, although examinations have not shown earthworms in the contents." It is interesting to note that when in the absence of other food earthworms were offered the shrews, they ate these animals with avidity. This suggests that when there is a scarcity of insects in nature the shrews are able to exist on a diet of earthworms.

Of all the live food placed in the cage, the most readily and vigorously attacked were the caterpillars and the crickets. House flies were occasionally offered the animals and they were always eaten.

No water was given either shrew during its life in captivity, other than that sprinkled in the cages to moisten the soil and moss.

The nest-box consisted of a small, low, round tin can with a hole cut through the lower part. The inside was filled with dried grass from an old *Microtus* nest. A removable lid was placed on the top. No materials were carried by the shrew for the construction of a nest. It hollowed out a hole in the center of the material already in the box, and used this for the reception of the young. If the top of the nest was opened for observation, the animal would quickly repair the damage by sealing the break with a mouthful of nest material. Two days previous to the birth of young, the female was seldom seen out of the nest-box. Small amounts of food were taken in and stored for use during this time.

No account of parturition or description of the newlyborn young of long-tailed shrews can be found. Referring to the young of *Sorex*, Jackson[4] says, "The litter of eight of *Sorex cinereus haydeni* collected by Stuart Criddle, at Aweme, Manitoba, are the youngest long-tailed shrews the writer has seen. Although of indeterminable age, they are undoubtedly at least 10 or more days old and more than half the size of adults."

BIRTH OF YOUNG

On the fifth of May, one dead young was found in the nest with our captive female. The individual was born between 11 a.m., May 4 and 10 a.m., May 5. It is possible the litter contained more individuals and that the mother devoured them, but there was no evidence to assume that she had done this. The nest was undisturbed and no blood or flesh of other young could be found. The dead individual exhibited no evidence of an attack by the mother.

Long-tailed shrews exhibit a great degree of physical vigor, and their life processes are carried on at an extremely rapid rate. It is known that in some other mammals there is a decrease in the number of young per litter with increase of age of the mother. The mother shrew, as will be shown later, was extremely old. It seems possible that a litter of one individual might be normal for an old female.

The measurements of the dead young shrew (less than one day old) are: To-

[2] Hamilton, W. J. Jr. 1930. Food of the Soricidae. Journ. Mammalogy, vol. 11, no. 1, p. 37.

[3] Jackson, H. H. T. 1928. *Op. cit.*, p. 10.

[4] Jackson, H. H. T. 1928. *Op. cit.*, p. 11.

tal length, 19 mm.; tail, 3 mm.; head (length), 7.2 mm.; interparietal, 4.2 mm.; interorbital, 3.1 mm.; internasal, 1.9 mm.; front foot (across digits), 1.2 mm.; hind foot (across digits), 1.0 mm.; umbilicus, 1.3 mm.; weight of alcoholic specimen, 0.1 gm. There is no trace of hair on the body of the newly born young. The teeth have not erupted, and the eyelids are still fused. The feet show well-defined grooves, but no separation into individual digits. In general the animal is in a very undeveloped state. The weight of the young (preserved in alcohol) is one thirty-fifth of the average weight of the normal mother. The body is dark grayish dorsally. Top of head and snout, light grayish shading into deeper gray on throat and belly. Feet and tail (tip of tail, gray), cream color. Region about eyes, dark. The skin is rough and resembles a small pickle with its corrugations. Upon close examination the pinna of the ear is seen as a small fold of skin.

When the nest containing the young individual was first opened the mother became extremely excited. She ran from the nest-box, uttering hurried and angry squeaks, and repeatedly returned to the nest to look in, but would not enter.

ATTEMPTED MATING

In an attempt to affect a successful mating between the two shrews, the male was placed in the female's cage and allowed to remain from 10 a.m., May 5 until 4 p.m., May 6. The female resented the approaches of the male by viciously snapping. He was continually driven away, and occasionally the female would pursue and drive the male farther away by snapping and biting. Her resentment was shown also by her angry squeaking. The next day the female was observed to be making advances to the male by following him about the cage. At one time, when the male turned to the female, she lay down on her belly but immediately ran away and there was no copulation. It was hoped that the period of gestation could be determined by this mating but no young were produced, although the female lived for 69 days afterwards.

On the morning of May 7, the male was found in a weakened condition, with a thick coating of dried mud attached to both hind feet. He was put into a pan with shallow water in the bottom and the mud was allowed to soak off. On May 10 he was found dead, with a similar coating of mud on the feet. Seven days before the death of the female, she was observed to be slower in movement. Food was not secured with the former activity and she remained more in the nest-box. There had been no change in the food offered, except that insects were more abundant now and more of these were given than formerly. Each day saw the shrew in a weaker condition until on July 13 she was found dead. An examination of the skull shows the teeth to be in an extremely worn condition, indicating very old age. The teeth were compared with those of 54 specimens of *Sorex cinereus cinereus*, ranging in locality from eastern Canada to Glacier Park. Only two of the 54 shrews had teeth exhibiting nearly equal wear; one being the male from Ann Arbor, and the other a male from Glacier Park.

It is known that a low potential longevity prevails throughout the insectivora. In view of the generally good condition of these shrews before death, and the obvious old age of the animals, as shown by the teeth, it seems that natural old age might be a possible explanation of their deaths.

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THE LESSER ONE-HORNED RHINOCEROS

By Thomas Barbour and Glover M. Allen

[*Plate 11*]

For many years there has been in the collection of the Museum of Comparative Zoology a mounted specimen of the lesser one-horned rhinoceros, *Rhinoceros sondaicus*, which apparently is the only mounted skin in any American museum. It was purchased of Ward's Natural Science Establishment at Rochester, New York, in 1880, and was said to have come from Java. Beyond this, nothing is known of its history, the record books of that great firm having been lost in the recent lamentable fire. The specimen is a somewhat immature female, and in place of a horn, has merely a large knob on the end of the snout. A photograph of the animal is given herewith, showing very well its general appearance, the very small horn, and the hooked upper lip, and also, unfortunately, the loss of hair on its tail.

A realization that this species is now actually on the verge of extinction has led us to call attention to the specimen and to make a census, no doubt imperfect, of the specimens at present preserved in other museums, in the hope that it will not only serve to bring other examples to light but also that it may emphasize the necessity of securing, if possible, a representation of the species ere it wholly disappears. For it is perhaps too much to expect that any amount of protective legislation will ever suffice to re-establish it over at least the continental portion of its former range.

The lesser one-horned or Javan rhinoceros is easily told from the larger Indian rhinoceros (*R. unicornis*), not only by its smaller size but by the pebbly nature of its skin, which appears as if studded with wart-like nodules. In both there is a prominent fold transversely at the hip, another just back of the shoulder, and a third at the base of the neck, so that the body seems to be divided into sections. A difference appears in the neck, which in the Indian rhinoceros has the skin fold at its base curved backward across the shoulder until it nearly reaches the fold behind the shoulder, whereas in *R. sondaicus* the fold is more nearly transverse, running from in front of the leg to the summit of the neck, with a small fold from the occiput back to the middle of the main neck fold, cutting off a triangular area on the nape. When full grown, the lesser one-horned species stands nearly as high at the shoulder as the larger, but its bulk is much less. One in the Liverpool Gardens about

1836 is said to have measured 4 feet, 8 inches at the highest part of the back; another, a large female, according to Cockburn (Proc. Asiatic Soc. Bengal, 1884, p. 140) stood 5 feet, 6 inches high, and its skull had a basal length of 23 inches. Dollman (1928) gives the height at shoulder as 5 feet, 10 inches. The skull is said to be easily distinguishable by the broader mesopterygoid fossa, with its palatal margin produced in the middle, and by its partially ossified nasal septum. The molar teeth differ in lacking the crista. The well-known monograph with illustrations by Sclater (1876), and his account of a Javan specimen with a colored plate (Sclater, 1874), may be referred to for additional details.

Formerly this rhinoceros had a somewhat extensive range, extending, according to Blanford (1888–91) from the Sundarbans and parts of eastern Bengal, the Sikkim Terai and Assam, throughout Burma and the Malay peninsula to Sumatra, Java, and Borneo. Probably, however, the statement of its occurrence in the Sikkim Terai, based on Kinloch, is erroneous, and Blanford discredits Jerdon's record of its presence in the forests of Orissa. It may be said, also, that the evidence for its occurrence in Borneo is far from good, being based in part on native report (see Sclater, 1869); and until recently even its presence in Sumatra was questioned. Positive evidence is now forthcoming, however, that it still occurs in Sumatra, for De Beaufort (1928) gives an account of a complete skeleton, presented to the Zoological Museum of Amsterdam, that was procured by a Mr. Keith, 250 kilometers southwest of Palembang, on that island. The same writer, in summarizing various notes on the range of the species, mentions that according to P. Vageler (in "Die Umschau," vol. 31, p. 289, 1927) a big-game hunter, G. C. Hazewinkel, killed in Sumatra no less than eight, which were supposed to represent a new variety, but in fact appear absolutely identical with Javan specimens.

At the present time it is likely that very few individuals of *Rhinoceros sondaicus* still exist in continental Asia. G. H. Evans (1905), writing of rhinoceroses in Burma, says that the two-horned *R. sumatrensis* is the commoner, and that during the previous eight or nine years he had known of only two *R. sondaicus* having been killed by Europeans. They occurred only in certain areas of hilly country in Upper and Lower Burma, preferring this type of terrain to the lowlands, and frequenting even mountainous districts. They are partial to water, especially streams with rocky or shingly beds, and like to roll in wet mud. During the day they lie up in the shade on hillsides or on the summits of ridges above streams. They appear to be browsers, and also to like fruit,

such as wild mangoes and figs; also leaves of trees, and bamboo. They swim well, crossing rivers, and in fighting bite with the large incisor teeth, use their horn, and finish by trampling an adversary. Shortridge (1915) confirms their hill-loving habits, saying that in the Dutch Indies they seem to be more of a mountain animal than is the Sumatran species. He knew of but a single one shot by a European in southern Tenasserim, some years previously at Victoria Point, but doubts not that a number are killed at water holes by natives, with whom the blood and horns are in great demand as medicine. More recently, C. Boden Kloss (1927) writes that, though formerly fairly numerous in Tenasserim and Java, only a few dozen individuals now survive, all "strictly protected," and that he has no evidence of the animal's presence in the Siamese portion of the Malay States. In Perak, lower Malay Peninsula, however, two individuals have been killed in the last thirty years, the mounted heads of which are now in the Selangor Museum of the Federated Malay States. The first of these was the locally famous Pinjih rhino, shot in 1899, in the Pinjih valley, Kinta district, by Sir George Maxwell. It was a male, standing 5 feet, 5.5 inches at the shoulder. The second was a female, killed April 16, 1924, at Kuala Serukoi, near Telok Anson, in Perak, by an unlicensed hunter. The skull and head skin only are preserved at the Selangor Museum. Both these animals were savage, and given to unprovoked attacks. The Pinjih rhino was a well-known individual and had been the terror of the valley long before the British occupation in 1874. It had killed at least three men and only large and well-armed parties went into its area. The 1924 cow rhino had come to notice through its having attacked a Chinese who was tapping jelutong in the forest. He was charged three times, tossed, and chased, but managed to escape. It was said that there was a second rhino in the neighborhood. No doubt single individuals such as the Pinjih bull, may, as the species dwindles in numbers, survive for many years in a chosen haunt without breeding, partly because they tend to be local in their habits, so that the survivors are too scattered to find one another.

The horn in this species is small, and in the female hardly developed. According to Rowland Ward's Records of Big Game, the largest known specimen measured $10\frac{3}{8}$ inches in height and is in the collection of the British Museum; a second of practically equal height and a third measuring $8\frac{1}{4}$ inches are privately owned. All three are from Java.

LIST OF SPECIMENS IN MUSEUMS

The following list includes all the specimens in museum collections of whose existence we have been able to learn. It is doubtless incomplete, for certainly there must be more in some of the European institutions or in private collections.

AMSTERDAM, HOLLAND, *Zoological Museum:* three complete skeletons, including the one from 250 km. southwest of Palembang, Sumatra, recorded by De Beaufort (1928); also two separate skulls.

BERLIN, GERMANY, *Zoologisches Museum der Universität:* Dr. Pohle kindly informs us, in reply to inquiry, that the Museum has in all five specimens of *R. sondaicus*, including a skeleton and three other skulls from Java, and a skull from Kapala Wuada, Sumatra, collected by Blandowski.

Although Dr. Pohle has been unable to trace the type of *R. jamrachii*, it may be that the specimen is still in Berlin which according to Sclater (1876) was taken in Manipur in 1874 and imported to London by the dealer, Jamrach. After remaining some time in London, it was transferred to the Berlin Zoological Gardens, where Peters pronounced it *R. sondaicus*, as had the zoologists in England. This determination did not satisfy Jamrach who, impressed by its large head, long ears, and the numerous boss-like excrescences of the skin, insisted that it represent an undescribed species. Since no naturalist would describe it, he decided to do so himself, and published an account of it in October, 1874, on a sheet of green paper, naming it *Rhinoceros jamrachii!* If the remains of the specimen were preserved, they constitute the type of this nominal species. Sclater (P. Z. S. 1880, p. 420) later announced that he believed this animal, as grown to adult size, represented *R. unicornis*. Since Professor Ward often got rare specimens from European Zoological Gardens it is by no means impossible that the specimen in the Museum of Comparative Zoology may be the lost type with the formal locality of "Java" added. Specimens from Zoological Gardens have a way of getting wrong localities attached to them.

BUITENZORG, JAVA, *Buitenzorg Museum:* K. U. Dammerman writes: "According to your request made in your letter of September 29th, I have pleasure in sending you a photograph of our mounted female rhinoceros of Java and two photographs of a head of a male of the same species, shot in South Sumatra. The female is an old and badly stuffed specimen and we ourselves are trying to get fresh specimens. But the species has already become very rare except in one of our reserves, where, however, we do not like to kill specimens. The Museum has one complete skeleton from Java and several skulls."

CALCUTTA, INDIA, *Indian Museum:* one adult female, mounted skin, from the Sundarbans, mouth of the Ganges, about 1870; one stuffed specimen, also the skeleton, collected in Sundarbans by O. L. Fraser and J. F. Barckley; one stuffed specimen, also the skeleton, collected in Sundarbans by J. F. Barckley; one skeleton and skull from Jessore District, collected by J. H. Barlow; one incomplete skeleton, locality and collector unknown; one skull, locality unknown, collected by M. Wallich, Asiatic Society Bengal; one skull from Tavoy Point, collected by Genl. Fytche, Asiatic Society Bengal; one skull from Java, Batavian Society, Asiatic Society Bengal; one skull from Sundarbans, collected by W. W. Shepperd; one skull from Chillichang Creek, Sun-

darbans, collected by Capt. Charling; one skeleton and sku" [illegible]ality and collector unknown; one lower jaw, locality and collector u[illegible].wn; two skulls, locality unknown, collected by W. Rutledge; one incompl[illegible]e skeleton, locality and collector unknown; one skeleton, locality unknown, collected by W. Rutledge.

CAMBRIDGE, MASSACHUSETTS, *Museum of Comparative Zoology:* a mounted skin from Java; a skull from west Java, received in exchange from the Buitenzorg Museum.

CLEVELAND, OHIO, *Western Reserve University, Laboratory of Anatomy:* a skull, probably from Sumatra, purchased from Gerrard, London, 1919.

KUALA LUMPOR, *Federated Malay States Museum:* a mounted head-skin of a male, Pinjih valley, Perak, 1899; a mounted head-skin and separate skull of a female, Kuala Serukoi, Perak, April 16, 1924.

LEYDEN, HOLLAND, *Leyden Museum:* a mounted skin (no other details available).

LENINGRAD, UNION OF SOVIET SOCIALIST REPUBLICS, *Museum of Academy of Sciences:* 2 mounted adult male skins; adult and juvenile skull; skeleton (adult). Information from Mr. H. J. Coolidge, Jr.

LONDON, ENGLAND, *British Museum:* (1) a mounted female shot by Mr. T. R. Hubback, from Tenasserim; (2) a mounted specimen of a young individual, probably the one mentioned by Sclater (1876a) as having been captured in the Sundarbans near the Ray Mangal River, in May, 1874. It died at Calcutta twenty-four months later, and the skin, brought by the dealer Jamrach to London, was supposed to be the first brought from there to England; in the following year Sclater (1877) mentions a second young one brought alive to London from the Sundarbans, a female, three feet high, and hornless. It died very soon after and became the subject of a paper by Garrod (1877) on the visceral anatomy of the species. (3) An adult skeleton from Java; (4) an imperfect skeleton from Sumatra, presumably the one mentioned by Gray (1867); (5) the skull with the record horn shot by Mr. Maxwell in Bantam, Java; (6) a skeleton of a half-grown individual; (7 and 8) two imperfect skulls of adults, without locality, from the Zoological Society. For the above list we are much indebted to Captain Dollman, Assistant Keeper, Department of Zoology, British Museum.

Royal College of Surgeons: eight skulls (four of them young), a mandible, and four molars. Of the skulls only two have a definite locality, namely, an adult from the Sundarbans, Bengal, 1859; and a very young one killed by the side of its mother, on the Malay coast, opposite Penang, in 1816. One of the skulls without definite locality is the type of *R. floweri* Gray. It is quite possible that the above information from Flower and Garson's Catalogue (1884) is not up to date.

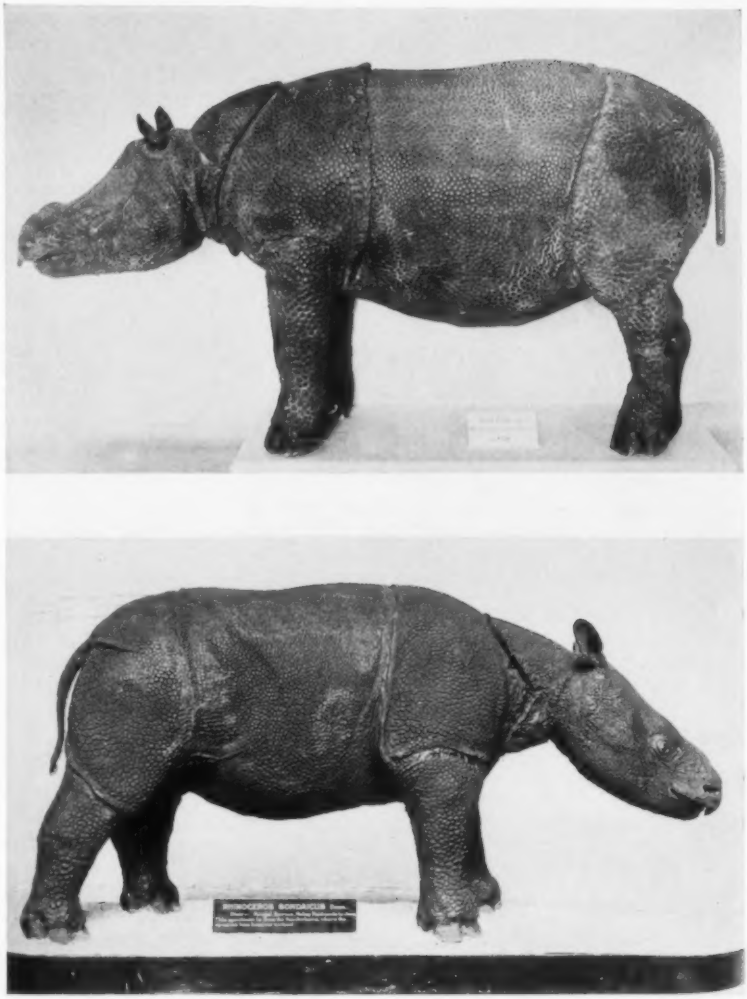
MELBOURNE, AUSTRALIA, *National Museum of Victoria:* one juvenile mounted specimen, no locality.

PARIS, FRANCE, *National Museum of Natural History:* one mounted specimen, about three quarters grown; three skeletons and two skulls.

STOCKHOLM, SWEDEN, *Riksmuseum:* Dr. Einar Lönnberg kindly informs us by letter that the Museum has an immature mounted skin, taken in Java, 1829.

WASHINGTON, D. C., *United States National Museum:* one cranium from Java.

In all, then, as a result of our inquiry, we have learned of but thirteen



TWO SPECIMENS OF RHINOCEROS SONDAICUS
UPPER: SPECIMEN FROM JAVA IN THE MUSEUM OF COMPARATIVE ZOOLOGY, CAMBRIDGE, MASS.
LOWER: SPECIMEN FROM THE SUNDARBANS OF BENGAL, IN THE INDIAN MUSEUM, CALCUTTA; THE LAST EXAMPLE KNOWN TO HAVE BEEN TAKEN IN THAT REGION

mounted skins of the animal, three mounted heads, seventeen skeletons, and some thirty skulls, young and adult. It would be interesting to know how many other specimens there may be in the museums of the world, and to be informed more exactly concerning the present status of the living animal.

LITERATURE CITED

BLANFORD, W. T. 1888–91. The fauna of British India, including Ceylon and Burma. Mammalia. 8 vo, London, xx + 617 pp.

DE BEAUFORT, L. F. 1928. On the occurrence of *Rhinoceros sondaicus* Desm. in Sumatra. Tijdschr. Nederl. Dierk. Vereen., Amsterdam, ser. 3, vol. 1, pp. 43–44.

DOLLMAN, J. G. 1928. A young Sumatran rhinoceros. Nat. Hist. Mag. (British Mus.), vol. 1, no. 7, pp. 255–258, fig.

EVANS, G. H. 1905. Notes on rhinoceroses in Burma, *R. sondaicus* and *sumatrensis*. Journ. Bombay Nat. Hist. Soc., vol. 16, pp. 555–561.

FLOWER, W. H. 1876. On some cranial and dental characters of the existing species of rhinoceroses. Proc. Zool. Soc. London, 1876, pp. 443–457.

FLOWER, W. H. and J. G. GARSON. 1884. Catalogue of the specimens illustrating the osteology and dentition of vertebrated animals, recent and extinct, contained in the museum of the Royal College of Surgeons of England. Part II. Class Mammalia, other than man. 8 vo. London, xliii + 779 pp.

GARROD, A. H. 1877. On some points in the visceral anatomy of the rhinoceros of the Sunderbunds (*Rhinoceros sondaicus*). Proc. Zool. Soc. London, 1877, pp. 707–711.

GRAY, J. E. 1867. Observations on the preserved specimens and skeletons of the Rhinocerotidae in the collection of the British Museum and Royal College of Surgeons, including the descriptions of three new species. Proc. Zool. Soc. London, 1867, pp. 1003–1032.

JENTINK, F. A. 1894. On the rhinoceroses from the East-Indian-archipelago. Notes from Leyden Mus., vol. 16, pp. 231–233.

KLOSS, C. BODEN. 1927. The one-horned rhinoceros in the Malay peninsula. Journ. Federated Malay States Mus., vol. 13, pp. 207–208, pl. 5.

SCLATER, P. L. 1869. [Letter from W. T. Fraser on the supposed occurrence of the Javan rhinoceros on Borneo.] Proc. Zool. Soc. London, 1869, p. 529.

SCLATER, P. L. 1874. [Arrival of a Javan rhinoceros at the London Zoological Gardens.] Proc. Zool. Soc. London, 1874, pp. 182–183, pl. 28.

SCLATER, P. L. 1876. On the rhinoceroses now or lately living in the Society's menagerie. Trans. Zool. Soc. London, vol. 9, pp. 645–660, pls. 95–99.

SCLATER, P. L. 1876a. [On a young *Rhinoceros sondaicus*.] Proc. Zool. Soc. London, 1876, p. 751.

SCLATER, P. L. 1877. [Note on a living *R. sondaicus* in London.] Proc. Zool. Soc. London, 1877, p. 270.

SHORTRIDGE, G. C. 1915. The Asiatic two-horned rhinoceros (*Rhinoceros sumatrensis* Cuv.). Journ. Bombay Nat. Hist. Soc., vol. 23, pp. 772–774.

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COSOMYS, A NEW GENUS OF VOLE FROM THE PLIOCENE OF CALIFORNIA

By Robert W. Wilson

[*Plate 12*]

Rodents are of rather common occurrence in the later Tertiary of North America, yet voles have been completely absent from the record with the exception of a single tooth of *Neofiber* found in the upper Pliocene San Pedro Valley beds of Arizona.[1] Consequently material representing this important group should prove of interest in an interpretation of the history of the voles in North America.

The specimens described in this paper are from late Cenozoic mammal-bearing beds exposed on the flanks of the Coso Mountains along the eastern margin of Owens Valley, nine and one-half miles east of Olancha, California. The age of the deposits from which the rodent material comes has been tentatively regarded as upper Pliocene by Dr. Chester Stock of the California Institute of Technology. A determination of age has been afforded chiefly by horse material from the same locality.

The author wishes to thank Dr. Stock for the opportunity to study the material and for advice during the course of the investigation. Specimens of Recent voles were loaned for comparison by Mr. Donald R. Dickey of the California Institute of Technology, and by the United States National Museum. Preparation of the illustrations was supervised by Mr. John L. Ridgway.

Cosomys primus, gen. et sp. nov.

Holotype.—No. 500, Calif. Inst. Technology, Coll. Vert. Paleont.; a badly crushed skull with basicranial region and bullae missing, but with complete dentition. Left and right fragmentary rami; dentition complete in right ramus, left ramus with cheek-teeth broken out. From Calif. Inst. Tech. Vert. Pale. locality 131, nine and one-half miles east of Olancha, Inyo Co., California.

Paratypes.—Mandible, No. 501, with dentition complete in right ramus. Mandible, No. 502, with left M_1 and M_2.

Generic diagnosis.—Mandibular incisor passing from lingual to buccal side of tooth-row. Proximal end of mandibular incisor terminating slightly above dental foramen. Cheek-teeth developing roots in adult life. M_1 with three closed triangles following the posterior loop, and an anterior loop of complex pattern. Dentine spaces of teeth confluent. Enamel thick, usually not noticeably differentiated into thick and thin tracts. Upper incisors without grooves. Temporal ridges of interorbital region weakly fused.

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[1] Gidley, J. W., U. S. Geol. Surv. Prof. Paper 131, p. 127, pl. 35, fig. 14, 1922.

Specific diagnosis.—Teeth with little or no cement. Inner triangles of lower teeth slightly larger than outer, especially on M_3. Inner triangles of upper teeth with rounded apices. Third outer fold in M_1 reduced to form a pit surrounded by enamel. Persistent "prism fold"[2] on M_1. Size approximately that of *Mimomys pliocoenicus*.

SKULL AND DENTITION

Study of the various genera of voles, living and extinct, shows that *Cosomys* resembles most closely in structure *Arvicola* and *Mimomys*. Neither of these genera is found in North America.

The skull of the genotype, Pl. 1, figs. 2, 2a, is too badly crushed to yield characters of importance, the region of the palate being almost entirely obliterated. The rostrum is not arched and the inferior border is straight from the palate to the anterior portion of the incisive foramina. The absence of an arched rostrum may be a primitive character for the straightness of the palate in this region is shown to some degree in *Phenacomys* and *Clethrionomys*, both primitive members of the existing voles. The temporal ridges in the interorbital region are only feebly fused in *Cosomys*. In this character the Californian genus appears to be intermediate between *Mimomys*, in which the temporal crests are not fused, and *Arvicola* in which the crests are clearly united, as seen at least in later Quaternary representatives of the genus.

In its molar features the enamel pattern of the teeth is very similar to that in *Arvicola* and especially to that in *Mimomys*. M^1, M^2, M_2, and M_3 possess the characteristic pattern seen in voles. M^1 (Pl. 1, fig. 4) has an anterior loop and four more or less closed triangles. M^2 has an anterior loop and three alternating triangles. M^3 possesses anterior and posterior loops, two triangles and the suggestion of a third, very small, postero-external triangle. In the first and second upper molars of *Arvicola*, in contrast to the corresponding teeth of *Cosomys*, the postero-external triangle is distinctly oblique to the principal axis of the tooth-row. Moreover, the postero-internal re-entrant angle in M^3 of *Cosomys* is deeper than in any of the specimens of *Mimomys* whose figures are available for comparison. This re-entrant angle is very deep and there is apparently no tendency to isolate the tip of the fold as in *Mimomys pliocoenicus*.

The position of the root of the mandibular incisor is clearly marked in the ascending ramus. The shaft of the condyle is bent inward with the posterior portion broad. The groove between molars and ascending ramus is open posteriorly, not pocketed as in *Arvicola*.

In the cheek-teeth of voles M_1 possesses perhaps the most complex enamel pattern. This tooth in *Cosomys* (Pl. 1, fig. 5) presents a posterior loop, three alternating triangles, and a complex anterior loop. The anterior loop exhibits the primitive "prism fold" of Hinton, even in a fairly worn tooth. An enamel islet is also present as in *Mimomys pliocoenicus* and in other species of this genus in the European Pliocene. In *Cosomys* where the teeth are devoid of cement the islet is in reality a pit surrounded by enamel. The origin of the pit in the Californian genus by an isolation of the tip of the third external re-entrant angle does not

[2] Hinton, Martin A. C., Monograph of the Voles & Lemmings (Microtinae) Living and Extinct, vol. 1, p. 111, London, 1926.

appear to be so clearly indicated as in *Mimomys*. It seems possible, at least, that the pit may have originated from an isolated tip of the third inner angle. However, if the pit were formed in this way it appears probable that greater tendency toward reduction of the inner angle would be exhibited than is actually the case. In either instance the angle has a greater forward extension than the corresponding angle in *Mimomys*, bringing the anterior tip opposite, or slightly in front of, the posterior margin of the third outer fold. If the islet or pit represents an isolation of the tip of the third outer angle it gives a forward direction to the angle instead of a backward direction as in very young specimens of *Arvicola* and in *Mimomys pliocoenicus*.

The pit or islet is present in two specimens of the first lower molars available. In a third specimen, representing this molar, the pit is absent but the crown shows greater wear than in the teeth in which the pit is present. The pit evidently persists long after the roots have started to form. With the exception of the anterior loop the tooth as a whole compares favorably with *Arvicola*. It resembles even more closely that in *Mimomys*, the chief difference being in the relation of the isolated enamel pit to the third inner and outer folds.

M_2 has a posterior loop and four closed triangles. M_3 has both posterior and anterior loops, and two closed triangles. These teeth are very similar to the comparable molars in *Mimomys* and in *Arvicola*.

The cheek-teeth in *Cosomys* appear to be somewhat wider than those in Recent *Arvicola*. In M_1 however the relative width of crown may not differ greatly from that in the latter genus. In view of the small number of specimens available the ratios of the posterior cheek-teeth may not represent average values.

RELATIONSHIPS

The position or orientation of the lower incisor within the mandibular ramus, as it passes from the lingual to the buccal side of the tooth-row in its backward course, is evidently a distinguishing feature in which the genus *Cosomys* is like a vole and differs from the lemmings. In modern voles with rooted cheek-teeth representing primitive members of the Microti the root of the lower incisor terminates well below the posterior dental foramen. Although the cheek-teeth may be rooted in *Cosomys* the termination of the mandibular incisor in this genus at a point slightly above the dental foramen suggests that the latter type is not closely related to living voles but is an early representative of a more progressive stem. The relatively complicated enamel pattern of the anterior lobe of M_1 is believed by M.A.C. Hinton to be a primitive character.

Among living voles the genus *Arvicola* apparently resembles *Cosomys* more closely in structure than does any North American form. Viewing the history of development of the voles as at present known one may presume that the most important change in the dentition since the upper Pliocene has been an increase in the length of the crowns of the cheek-teeth, while only minor changes in crown pattern have occurred.

A single tooth, possibly M^3, from the San Pedro Valley beds of Arizona, was referred to *Neofiber* by Gidley.[3] The base of the crown in this specimen is closed and small roots are present, in which respect this type differs from living speci-

[3] Gidley, J. W., *op. cit.*, p. 127, 1922.

mens of the genus. Possibly Gidley's specimen belongs to the genus *Cosomys*. Unfortunately the description and illustrations do not permit a more detailed comparison with the Californian material. It is of interest to note that the San Pedro Valley beds, whence this specimen came, are also regarded as of upper Pliocene age. According to Gidley the collections obtained from these deposits are known principally from two localities. While the latter are inseparable in so far as their stratigraphic position is concerned the two assemblages suggest a difference in age. The locality that yielded the tooth of *Neofiber* furnished also the remains of *Dibelodon*, *Equus*, *Lama*, *Procamelus*, *Pliauchenia*, *Odocoileus*, *Merycodus*, and *Glyptotherium*. The list includes both Pliocene and Pleistocene genera. A reworking of the material in the course of deposition of the sediments at this locality may account for the apparently anomalous association of types. Were this ultimately determined to be the case *Neofiber* may be a contemporary of *Equus*, *Lama*, and *Odocoileus*, and of Pleistocene age.

The nearest relatives of *Cosomys* among fossil forms, as suggested by structural characters on which comparison can be made at present, are the genera *Mimomys* and *Arvicola* of the European Pliocene and Pleistocene. According to Hinton[4] the genus *Mimomys* ranges upward stratigraphically from the Norwich Crag to the High Terrace of the Thames while the earliest occurrence of *Arvicola* is recorded from the Middle Terrace of the Thames. The latter genus survives today and is presumed to have been derived from *Mimomys*.

While the Norwich Crag is regarded by most European authorities as of upper Pliocene age, Haug refers this formation to the lower Pleistocene. In either instance, however, the Norwich Crag fauna has a position in the later Cenozoic succession near that of the assemblage from the deposits in the region of the Coso Mountains.

The geographic separation of the Californian and European localities lessens somewhat the possibility of generic identity of *Cosomys* and *Mimomys*, although it should be borne in mind that some living genera of rodents are widespread in their distribution over the northern hemisphere. Possibly the Californian genus is older geologically than *Mimomys*. Aside from the geographic and geologic position of these forms it is possible that the characters in which *Cosomys* resembles *Mimomys* relate to the more primitive structural features which may be found in other Pliocene voles. There are, on the other hand, some noteworthy differences. In *Cosomys* the temporal ridges are weakly fused, while in the European genus this fusion is not known to occur. In the late Pleistocene and Recent *Arvicola*, however, the crests are fused so far as is known. Moreover, the enamel patterns developed in the last upper molar and first lower molar of *Cosomys* differ at least to a slight extent from those seen in *Mimomys*. For the purposes of comparison it should be stated that the alveolar length of the lower tooth row of *Mimomys* varies from 7.0 to 8.5 mm., while that of *Cosomys* varies from 7.1 to 7.8 mm.

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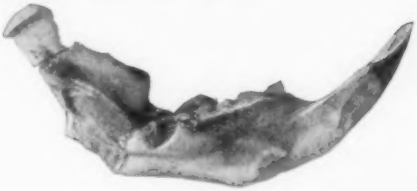
[4] Hinton, Martin A. C., *op. cit.*, vol. 1, pp. 126–136, London, 1926.

Comparative measurements (in millimeters)

	COSOMYS PRIMUS HOLOTYPE C.I.T. NO. 500	COSOMYS PRIMUS PARATYPE C.I.T. NO. 501	COSOMYS PRIMUS PARATYPE C.I.T. NO. 502	ARVICOLA AMPHIBIUS U. S. N. M. NO. 152934	ARVICOLA AMPHIBIUS U. S. N. M. NO. 152931
Least width of interorbital constriction	3.5	...	...	4.3	5.0
Length of nasal	9.5[a]	...	...	10.9	10.7
Width of nasal	2.9?	...	...	4.4	4.9
Length of diastema between I and M^1	9.6	...	...	15.6	14.2
Height from edge of palate to top of skull	8.6	...	...	14.0	13.0
M^1, anteroposterior diameter	2.7	...	...	3.9	3.6
M^1, transverse diameter	1.7	...	...	2.2	2.1
M^2, anteroposterior diameter	2.1	...	...	2.7	2.7
M^2, transverse diameter	1.6	...	...	1.8	1.8
M^3, anteroposterior diameter	2.1	...	...	2.7	2.6
M^3, transverse diameter	1.3	...	...	1.5	1.5
Length of upper tooth row (alveolar)	7.4[a]	...	...	10.3	9.4
M_1, anteroposterior diameter	3.2	3.2	3.0	4.2	3.8
M_1, transverse diameter	1.5	1.6	1.4	1.9	1.9
M_2, anteroposterior diameter	2.0	2.2	1.8	2.5	2.6
M_2, transverse diameter	1.5?	1.5	1.3	1.5	1.7
M_3, anteroposterior diameter	1.9	1.8	...	2.5	2.7
M_3, transverse diameter	1.1	1.3	...	1.2	1.3
Length of lower tooth row (alveolar)	7.1	7.8	7.6	9.9	9.5

[a] Approximate.

Balch Graduate School of the Geological Sciences, California Institute of Technology.



1

2a

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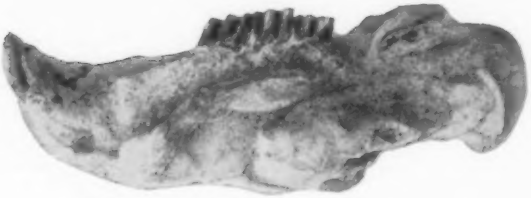

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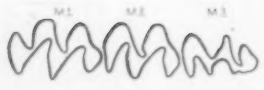

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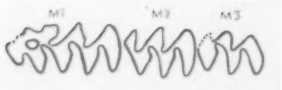

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SKULL, MANDIBLES, AND CHEEK TEETH OF COSOMYS PRIMUS WILSON

FIG. 1. *Cosomys primus* Wilson; lateral view of ramus; cat. no. 500, Calif. Inst. Technology, Coll. Vert. Paleont.; Upper Pliocene, Coso Mountains, Calif.; approx. X 3.

FIGS. 2, 2a. *Cosomys primus* Wilson; lateral and ventral views of skull; cat. no. 500, Calif. Inst. Technology, Coll. Vert. Paleont.; Upper Pliocene, Coso Mountains, Calif.; approx. X 3.

FIG. 3. *Cosomys primus* Wilson; dorsal view of ramus; cat. no. 501, Calif. Inst. Technology, Coll. Vert. Paleont.; Upper Pliocene, Coso Mountains, Calif.; approx. X 3.

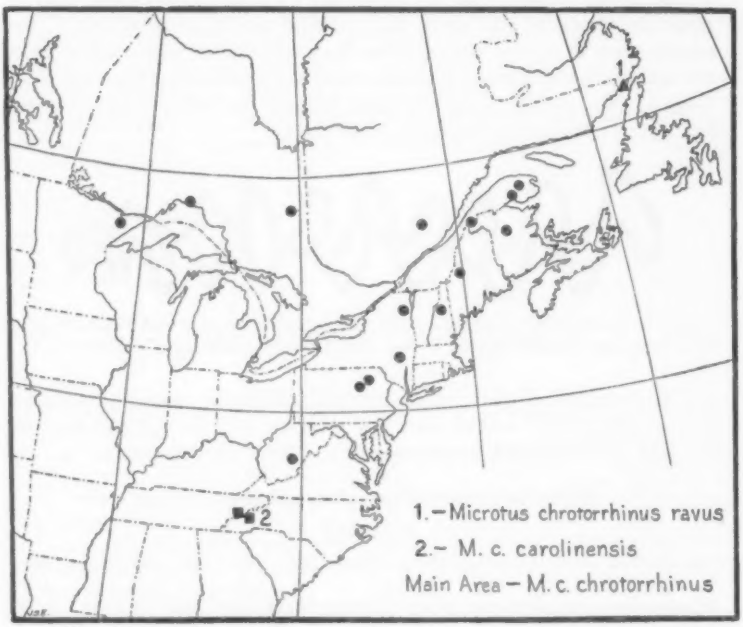
FIG. 4. *Cosomys primus* Wilson; right upper cheek teeth; cat. no. 500, Calif. Inst. Technology, Coll. Vert. Paleont.; Upper Pliocene, Coso Mountains, Calif. approx. X 5.

FIG. 5. *Cosomys primus* Wilson; right lower cheek teeth; cat. no. 500, Calif., Inst. Technology, Coll. Vert. Paleont.; Upper Pliocene, Coso Mountains, Calif.; approx. X 5.

DISTRIBUTION OF MICROTUS CHROTORRHINUS, WITH DESCRIPTION OF A NEW SUBSPECIES

By E. V. Komarek

In making a preliminary survey of the vertebrate fauna of the Great Smoky Mountains of Tennessee and North Carolina for the Chicago Academy of Sciences and the University of Chicago, in the spring of 1931, R. L. Boke and the writer collected a small series of *Microtus* in



the wooded slopes on the mountains above 3000 feet elevation. Upon examination it was found to belong to the *chrotorrhinus* group and to be worthy of a new name. In describing this new form it was considered necessary to make an examination of other forms of the group.

The writer wishes to express his appreciation of the helpful assistance, criticism, and suggestions given him, especially to Mr. R. L. Boke, co-collector of the new form from the Smoky Mountains; Dr. W. H. Os-

good, Field Museum of Natural History; Mr. A. M. Bailey, Director, Chicago Academy of Sciences; Dr. W. C. Allee and Dr. A. E. Emerson of the University of Chicago; Mr. Tappan Gregory; to Mr. Vernon Bailey, U. S. Biological Survey, who kindly furnished the locality records from Ontario and Minnesota; and to the U. S. Biological Survey, the American Museum of Natural History, the Museum of Comparative Zoology, the Field Museum of Natural History, and to the Boston Society of Natural History for the loan of material.

The *chrotorrhinus* group is characterized by unique dentition (fig. 1) which is somewhat similar to that of *Microtus xanthognathus*. Close examination of a large series shows that the number of closed or open triangles in the last upper molar is variable; in one specimen from West Virginia (No. 167975, U. S. Biological Survey) the left M^3 has one angle less than in the other specimens examined.

FIG. 1. Tooth pattern of upper molar series in *Microtus chrotorrhinus carolinensis* (type) near Smokemont, N. C. No. 1506, Chicago Academy of Sciences.

The members of this group resemble *Microtus pennsylvanicus* in general appearance and in size, but the two may be distinguished in the field by the reddish or orange-rufous nose in *chrotorrhinus*.

Microtus chrotorrhinus chrotorrhinus (Miller)

Rock Vole

Arvicola chrotorrhinus Miller, Proc. Boston Soc. Nat. Hist., vol. 26, pp. 189–193, pl. 3. 1894.

Microtus chrotorrhinus Bangs, Proc. Biol. Soc. Washington, vol. 10, p. 49, 1896.

Type locality.—Mount Washington, Coos County, New Hampshire, head of Tuckerman's Ravine (altitude, 5,300 feet).

Distribution.—Known from Quebec, New Brunswick, Maine, New Hampshire, Adirondacks and Catskills, New York, Pennsylvania,[1] West Virginia, northern Minnesota, and western Ontario.

General characters.—Size and proportions of *Microtus pennsylvanicus* but with slightly smaller hind foot; ears larger; slightly yellower in color; nose, ears, and

[1] M. M. Green: A contribution to the mammalogy of the North Mountain region of Pennsylvania, 1930, p. 17.

rump conspicuously bright orange-rufous; dentition unique, resembling that of *Microtus xanthognathus*.

Color.—Summer pelage: Upper parts glossy bister mixed with blackish hairs; nose to eyes and base of ears, orange-rufous with a faint wash of the same color on the rump; belly plumbeous. *Winter pelage:* very similar, slightly darker on upper parts.

Skull.—Skull light and smooth, slightly arched braincase, superficially resembling the skull of *Clethrionomys;* incisors bent down at right angles to axis of skull and not protruding past the plane of nasals; incisive foramina short and wide; dentition as in figure 1. Average skull measurements of seven topotypes: greatest length, 25.8 mm. (25–26.7); greatest zygomatic breadth, 14.3 mm. (13.5–15.3); alveolar length of upper tooth row, 6.5 mm. (6.2–6.9); least interorbital breadth, 3.7 mm. (3.5–3.9).

Remarks.—Differs from *M. c. ravus* in having a larger skull, heavier dentition, and longer tooth row.

Specimens examined.—New Hampshire: Mount Washington (type locality), 14; West Virginia; Pocahontas Co., 8; Quebec: Lake Edward, 8; Cascapedia River, 9; New Brunswick: Gulquac Lake, 1; Trousers Lake, 4; a total of 44 specimens.

The skulls of eight specimens from Pocahontas County, West Virginia, average slightly larger than those of *chrotorrhinus* but smaller than those of the new race; they seem to be more closely allied to the former, as the zygomata are not heavy and the color is also the same.

Microtus chrotorrhinus ravus Bangs

Gray Rock Vole

Microtus chrotorrhinus ravus Bangs, Proc. Biol. Soc. Washington, vol. 12, p. 187. Nov. 16, 1898.

Type locality.—Black Bay (north shore of Strait of Belle Isle), Labrador.

Distribution.—Known only from the type locality.

General characters.—Similar to *chrotorrhinus*, but slightly grayer; skull smaller, slenderer and with much lighter dentition.

Color.—Slightly grayer than *chrotorrhinus*, otherwise very similar in coloration. The difference in color is not so evident when single individuals are compared but is noticeable in a series.

Skull.—Compared with that of *chrotorrhinus;* smaller, slightly lighter braincase, incisive foramina longer; upper tooth row shorter and narrower; dentition finer. Average skull measurements of seven specimens from the type locality: Greatest length, 23.9 mm. (21.7–26.5); greatest zygomatic breadth, 13.2 mm. (11.2–14.3); alveolar length of upper tooth row, 5.9 mm. (5.4–6.5); least interorbital breadth, 3.9 mm. (3.5–4.2).

Remarks.—Differs from *chrotorrhinus* in smaller skull, shorter and lighter tooth row, and lighter dentition.

Specimens examined.—15 from the type locality, Black Bay, Labrador.

Microtus chrotorrhinus carolinensis new subspecies

Smoky Mountain Rock Vole

Type locality.—Great Smoky Mountains of North Carolina, about five miles (airline distance) north of Smokemont, Swain Co., on a tributary of Bradley Fork, a small branch of the Oconalufty River, at an altitude of 3200 feet.

Type.—No. 1506, Chicago Academy of Sciences; adult male, collected by E. V. Komarek and R. L. Boke, April 18, 1931; original number K-1104. Measurements in flesh: Total length, 161 mm.; tail, 44 mm.; hind foot, 22 mm.

General characters.—The darkest of the *chrotorrhinus* group; skull larger, with longer upper tooth row and heavier zygomata than any other member of this group.

Color.—Upperparts dark, blackish bister; sides slightly blacker; nose to eyes deep orange-rufous; small spot of rufous back of ear (not found in all specimens); underparts dark plumbeous; tail dark above, same color as back, lighter below.

Skull.—Larger and heavier than *chrotorrhinus* or *ravus*; longer upper tooth row; heavier zygomata; shorter incisive foramina; dentition as in figure 1. Measurements of skull (type): greatest length, 26.5 mm.; greatest zygomatic breadth, 15.2 mm.; alveolar length of upper tooth row, 7.1 mm.; least interorbital breadth, 4.1 mm.

Remarks.—This form differs from *chrotorrhinus* and *ravus* by having a larger skull, longer tooth row, heavier zygomata, and is distinctly much darker in color.

Distribution.—Known only from the wooded slopes above 3000 feet altitude of the Great Smoky Mountains of Sevier County, Tennessee, and Swain County, North Carolina. The specimens from Bradley Fork, near Smokemont, N. C., were taken along two small creeks in traps set near rotted and moss-overgrown logs resting on rocky terrain, near rhododendron thickets. Those taken in Tennessee were trapped in similar situations, always within about 50 feet of some small rivulet, but not on its banks. All were found in rather open forest having a dense crown.

Specimens examined.—4 from type locality (including type) and 2 from Sevier County, Tennessee, taken at an elevation of about 4300 feet on the Dry Sluice Trail near the divide (Mt. Collins).

Chicago Academy of Sciences and the University of Chicago.

GENERAL NOTES

ON THE FOOD HABITS OF MARMOSA

On June 3, 1931 a small boy came to me with a dead female opossum of the genus *Marmosa*. She had six living young attached to her mammae and fur. The boy had obtained them at a wholesale fruit store in Lincoln, Nebraska, where they had been found in a bunch of bananas. The mother had been killed with a banana knife.

Being ignorant of the food habits of these animals, I appealed to Dr. Otis Wade of this department and he referred me to an article by Robert K. Enders in Science, April 25, 1930. Enders was of the opinion that the principal article of diet is ripe banana. He conjectured that they might possibly eat insects also.

The six specimens in my possession were immediately put on a diet of ripe banana and milk. They would lick pieces of banana rather indifferently, but seemed to relish milk sweetened with syrup. The latter was given them with a small pipette. Within a few days they began to look underfed and it was apparent that they could not long survive on this diet. Their bodies became emaciated and the coelom was enormously distended with a clear watery fluid.

On June 12 some moths were placed in the cage. Immediately the half-starved opossums took a new interest in life and began devouring these insects ravenously. Grasshoppers also proved to be very palatable to them, and the two opossums that survived the first two weeks ate hundreds of them during the summer, and grew rapidly. Although seeming to prefer insects to all other food, they ate bananas, peaches, grapes, bat carcasses, viscera of mice and birds, and earthworms.

Apparently these small opossums are almost as omnivorous as our large North American species, at least under certain conditions. However, they lean strongly toward the insectivorous habit and capture live insects with great gusto.

Mr. Gerrit S. Miller, Jr. of the U. S. National Museum has kindly examined the skin and skull of the mother and thinks that it is probably *Marmosa zeledoni*.—GEORGE E. HUDSON, *Dept. of Zoology and Anatomy, University of Nebraska, Lincoln.*

OCCURRENCE OF MEXICAN BULLDOG BAT IN PANAMA

Recently the collection of the San Diego Society of Natural History has been enriched by the accession of an unusual bat. As it was unknown to the writer it was submitted to the U. S. Bureau of Biological Survey and through the courtesy of E. A. Goldman the following identification was received.

Noctilio leporinus mexicanus—Mexican bulldog bat. This specimen, an adult female, was collected by V. D. P. Spicer, of the U. S. Navy, one mile off shore in Panama Bay, Panama, on March 15, 1931. The bat flew on board the ship shortly after dark on the above date, while the ship lay at anchor. Mr. Spicer preserved the specimen and presented it to the San Diego Society of Natural History, where it now bears catalogue number 8856.

This form was described by Goldman in the Proceedings of the Biological Society of Washington, vol. 28, p. 136, June 29, 1915, from Papaya, Guerrero, Mexico. Goldman states in a letter to the writer: "I was especially interested in the *Noctilio*, as it is an exceedingly rare bat in continental North America,

and was not obtained by me in Panama." This specimen constitutes the third of these bats to be recorded from Panama. The first published record comprised two alcoholics listed by Glover M. Allen and Thomas Barbour as taken in Panama. (Bull. Mus. Comp. Zool., vol. 65, no. 8, Feb. 1923, p. 270).—LAURENCE M. HUEY, *Natural History Museum, Balboa Park, San Diego, California.*

THE LARGE-EARED FREE-TAILED BAT IN SAN DIEGO

A very unusual bat, an adult male *Tadarida macrotis*, now number 8588 in the collection of the San Diego Society of Natural History, was received on December 30, 1930, in a mummified condition from Will Hemsley, a custodian at the San Diego Museum. He had found it hanging in an upper corner of the splay of a glazed lancet window seven feet above the floor within a room in the tower of the California Building, which is one of the San Diego Museum group in Balboa Park, San Diego, California.

This species was first described from Cuba by Gray in the Annals of Natural History, vol. 4, pp. 5–6, September, 1839. H. H. Shamel, of the U. S. National Museum, who identified the present specimen, has lately revised the group (Proc. U. S. Nat. Mus., vol. 78, art. 19, pp. 1–24, 1931) and states that no less than six synonyms have been applied to this species. Relatively few specimens are known and these are from widely separated regions. A single alcoholic without data has been ascribed to California under the name of *Nyctinomus depressus*. The San Diego Museum individual definitely places this bat on the California list, with a known locality, but as the animal had long been dead the time of its occurrence remains uncertain.

The tower room in which the bat was discovered is about 75 feet above the ground. That it sought such a height apparently adds evidence to the already known fact that certain species of the larger bats must have considerable space beneath their roost for a successful "take-off" (See Howell, Journ. of Mammalogy, vol. 1, no. 3, p. 112). Entrance to the fairly large room had evidently been gained where a winding steel stairway descends in the center from an open section of the tower above. Apparently the bat had exhausted itself seeking a means of escape about the walls of the room, without finding the opening in the very center.—LAURENCE M. HUEY, *Natural History Museum, Balboa Park, San Diego, California.*

MYOTIS SUBULATUS LEIBII AND MYOTIS SODALIS IN PENNSYLVANIA

Though described by Audubon and Bachman ninety years ago, *Myotis subulatus leibii* is the rarest of our eastern bats. Miller and Allen in their revision of "The American Bats of the Genera Myotis and Pizonyx" (U. S. National Museum Bulletin, No. 144, 1928) listed only eight specimens examined—two from different localities in Vermont and specimens from single localities in Kentucky, Maryland, New York, and West Virginia. The type locality is Erie County, Ohio, but the type specimen is not known to be in existence.

Accordingly, the discovery of two specimens in Pennsylvania is worthy of note. On January 28, 1931, I found a single individual, a female, in Woodward Cave, a commercial cave near Woodward, in Centre County. As the result of a series of delays, during which a collection of mammals was being prepared, the bat became

mummified and is preserved in that condition. There were about 100 bats of other species in the cave—chiefly *Myotis lucifugus lucifugus*, with some *Eptesicus fuscus fuscus* and a few individuals of both races of *Pipistrellus subflavus*.

The second record for the state was made December 13, 1931, when I found a single specimen, a female, in a fairly large but undeveloped cave on the farm of Dayton M. Aitkin, near Siglerville, Mifflin County, just eleven miles across the Seven Mountains from Woodward Cave. In the same cave were large numbers of *Myotis sodalis* and *Myotis lucifugus lucifugus*, a few *Eptesicus fuscus fuscus* and a single pigmy bat apparently more closely approachng *Pipistrellus subflavus subflavus* than the northern race.

The *Myotis subulatus leibii* were solitary although the second one was hanging within a few yards of large clusters of *Myotis sodalis*. They were very readily identified by the black ears and facial mask which contrast quite sharply with the rather golden tint of the hair.

The measurements of the second specimen follow: head and body, 47 mm., tail, 32; tibia, 14; foot, 7; forearm, 31; thumb, 5.5; ear from crown, 11; width of ear, 9. It weighed 4.12 grams. The only measurement of value on the mummy is that of the forearm—31 mm. Both specimens are in the collection of the Reading Public Museum and Art Gallery.

During November and December, 1931, I visited about forty-five caves in Pennsylvania, practically all the known caves of any size. The hibernating bats in each cave were studied closely, a total number of ten thousand or more. Accordingly the record of a single specimen of *Myotis subulatus leibii* during that time gives some indication of its comparative rarity.

Myotis sodalis, described by Miller and Allen, is known to hibernate in great numbers in Mammoth Cave, Kentucky, and in Wyandotte Cave, Indiana, the type locality.

The only record for Pennsylvania is given by Miller and Allen (p. 130) as "Cave, Centre County." In a former paper ("Preliminary Report on the Mammals of Pennsylvania:" Proceedings Pennsylvania Academy of Science, Vol. 5, 1931), I attributed this record to Woodward Cave, but subsequent study of Centre County caves, and communication with Vernon Bailey has convinced me that the original Pennsylvania specimens came from Penn's Cave, where it is the common bat.

I found *Myotis sodalis* in two new localities on November 29, 1931. In Hipple Cave, Bedford County (commercial, but closed during the winter), I saw 300 to 500 bats of this species and collected a small series. It was the common bat. In Historic Indian Cave, Huntingdon County (commercial, open throughout the year), I found only four bats, one of which proved to be this species. On December 13, 1931, I found it in two more localities. In the cave on the Aitkin farm, in Mifflin County, there were several hundred individuals of *Myotis sodalis*, and probably five thousand *Myotis lucifugus lucifugus*. The two species could be distinguished without much difficulty. In Woodward Cave, Centre County, a single individual was taken, the first found in more than half a dozen trips made to that cave. As already mentioned, it is the common bat in Penn's Cave, Centre County, about two thousand individuals hibernating there.—CHARLES E. MOHR, *Reading Public Museum and Art Gallery, Reading, Pa.*

LASIURUS SEMINOLUS IN PENNSYLVANIA

On September 12, 1931, Samuel Wishnieski, of the Reading Public Museum, while collecting bats over a pond at Hopewell, Berks County, secured a female specimen of *Lasiurus* that I immediately suspected of being *Lasiurus seminola* Rhoads. It was taken with a number of the common red bats, *Lasiurus borealis borealis*, which appeared to be migrating at the time, and was apparently associated with them.

On comparing the specimen in question with the series of *Lasiurus* at the Academy of Natural Sciences, and especially with Rhoads' type of *seminola*, I found it to agree closely in all particulars with the type. It is, if anything, darker in color, approaching Ridgway's "claret brown." It is much larger than any of the type series, but agrees with specimens taken since that time.

The dimensions of this Pennsylvania specimen were: Length 112 mm.; tail vertebrae 48 mm.; hind foot 10 mm. The skull is correspondingly larger than that of the type. I have since showed the specimen to Gerrit S. Miller of the National Museum, who unhesitatingly pronounced it *seminola*.

Since this bat has not been taken, to my knowledge, north of South Carolina, the present specimen seems of unusual interest, especially since there had been no severe tropical storms previous to its capture.—Earl L. Poole, *The Reading Public Museum and Art Gallery, Reading, Pa.*

A THIRD RECORD OF THE SPOTTED BAT (EUDERMA MACULATA) FOR CALIFORNIA

On the morning of August 17, 1931, Mr. Robert Selby, custodian of the Yosemite National Park Museum, in Yosemite Valley, California, brought a live specimen of the rare spotted bat, *Euderma maculata*, to me in the museum laboratory where I was employed during the past summer, collecting and preparing birds and mammals for the park museum. As this is the first time it has been possible to observe this species of bat in life, it seems worth while to record its behavior during the short time it remained under our observation.

The cook at the government mess hall first noticed the bat hanging on the side of this building, under the eaves. He took a great interest in it and attempted to feed it various kinds of insects, which it refused to eat. However, the bat readily drank water whenever it was offered. After the second day the cook called Mr. Selby's attention to his queer pet, as it still remained in the vicinity of the mess hall, after having been repeatedly caught and freed again.

Mr. Selby immediately brought the bat to the museum for identification. Here we observed it for some time before taking it out into the sunshine to photograph. At first it remained quite still, but after being exposed to the sun's direct rays for a few moments, it became very restless and thrashed about on the end of the string to which it was tied, until it became exhausted. We then took it back into the shade, but it died in a few minutes.

The bat when excited made a queer grinding noise, by gnashing its teeth, but did not squeak as most bats do.

The specimen was made into a study skin and is now number 262 of the mammal collection of the Yosemite Museum. The skeleton is also preserved under the same number. The sex is male, and the measurements are as follows: length, 107 mm.; tail, 48; foot, 8; ear, 42.

The altitude of the locality is 4045 feet, in the Transition Zone, surrounded by a heavy coniferous forest. During the time the bat was under observation, the weather was unusually hot and sultry.

The sooty black coloring, with the three conspicuous white patches on the back, set in a triangle, make this species unmistakable, and are precisely as described for the type by Dr. J. A. Allen (Bull. Amer. Mus. Nat. Hist., vol. 3, 1891, pp. 195–198). The type specimen was found on a fence, near Piru, Ventura County, California, in March, 1890. This remained the only known specimen of the spotted bat for thirteen years, when a second specimen, taken in September, 1903, at Mesilla Park, New Mexico, was recorded by G. S. Miller, Jr. (Proc. Biol. Soc. Washington, vol. 16, 1903, pp. 165–166). A third specimen is recorded by Frank Stephens (California Mammals, 1906, p. 264) from Yuma, Arizona. The fourth record for the species, and the second record for the state of California is reported by Dr. Joseph Grinnell (Univ. Calif. Publ. Zool., vol. 5, 1910, pp. 317–320) from Mecca, Riverside County, California, October 1, 1907. Thus the specimen under discussion becomes the third record for the state of California, and, as far as I have been able to learn, the fifth record for the species.

From our meagre information, it is apparent that *Euderma maculata* is a bat of the desert and adjoining mountain ranges, with a range from 189 feet below sea level at Mecca to high Transition zone in Yosemite Park. It is doubtful if the spotted bat will ever be found in any numbers, as it appears to be of solitary habits, not having been observed associating with other bats, either in flight or in roosting places.—GRANVILLE P. ASHCRAFT, *9052 Hubbard Street, Culver City, California.*

A WEASEL ATTACKS A MAN

The ferocity of the weasel and its actual attack on man have been previously observed. Seton summarizes the information in his discussion of the weasel's courage and hardihood in his book, "Lives of Game Animals." He quotes Burroughs' report of an attack on a man who had interferred with the weasel's feasting on a newly-killed rat. "It dodged his blows of sticks and stones in a way 'singularly uncanny and startling. It was like some infuriated Satan, dancing before him and watching the chance to seize him by the throat or dash into his eyes.' "

On July 23, 1931, I experienced a first-hand encounter with a weasel, *Mustela noveboracensis*, which further demonstrates the blind aggressiveness of this notoriously persistent little animal. During the last three days in June we had placed thirty hens in coops with day-old pheasants, for the purpose of conducting a rather large scale open range rearing project designed for experimental purposes. The hens with their flocks were scattered throughout an 800-acre tract of land in Williamston Township, Ingham County, Michigan. After the first few days they were liberated from the coops each morning at sunrise. At about 6:00 o'clock on the morning of this incident three of the hens were feeding with their young in a sedge and blue-joint marsh intermixed with dense shrub growth. I had just left this region when hen No. 9, a brown leghorn, began making a loud commotion. Upon running back, I found the hen in a much excited condition, but uninjured. At that moment hen No. 8, a barred rock, was heard making squawks of distress. This was at a distance of 15 rods from where No. 9 had been disturbed, and upon quickly locating hen No. 8 I found that a weasel held her by

one leg. The weasel ran into the dense sedge cover, but as I turned to the hen it returned and came directly for me. I had kicked it off several times, when it suddenly ran about me and once more pounced upon the hen, this time burying its head beneath her wing where it successfully obtained a firm hold. I made a dive for the pair, and came up with the hen in one hand and the weasel firmly grasped, as I thought, about the neck. I had missed my opportunity, however, as my grasp was really well back of the front legs and about the abdomen. I quickly turned the weasel loose and felt fortunate in being able to do so, as my mind reviewed a previous experience with a young mink in Oregon. This animal had been taken alive in a box trap by Wallace Smith, and had been placed in a knapsack. In an attempt to make the mink more secure, Smith was suddenly grasped through the fleshy part of the hand at the base of the thumb. The animal then proceeded to drive its canines deeper and deeper, causing intense pain; every attempt to loosen its hold caused it to hold on more firmly. An unsuccessful attempt was then made to choke the animal into submission. We then next tried to pry its jaws loose, but also without success. Smith insisted on keeping his captive alive, and so we were finally forced to go back about half a mile to a creek and not until the mink was finally immersed did it loosen its hold.

Throughout the encounter the weasel seemed to depend almost entirely upon scent. It demonstrated some fear in first running away, but the return attack upon me was evidence enough that fear was overcome by the controlling stimulus to pursue its prey. There was no evidence of infuriation, but rather a well directed offense at the one object, regardless of its size, which stood between the weasel and an opportunity to satisfy its desire to kill, which was probably based upon the uncontrollable urge of hunger pangs.

The weasel's movements were apparently slow, and resembled the lumbering attempts of a hungry hound pup to locate a bone through the sense of smell, but once it had circled me and located the prey, its sudden and accurate leap at the hen quieted any doubts regarding the accuracy of the common saying "as quick as a weasel." Throughout the experience I saw nothing to indicate that man had in the weasel a very dangerous combatant. However, the effectiveness of this weasel's attack on the hen was demonstrated by the fact that it had broken its victim's femur and had lacerated the muscles in the region of the humerus, thereby making the bird an easy victim had the attack been permitted to continue.—H. M. Wight, *School of Forestry & Conservation, University of Michigan, Ann Arbor, Michigan.*

MID-WINTER ACTIVITY IN A STRIPED SPERMOPHILE

While enjoying a rare "green" Christmas on the golf-course at Green Bay, in northeastern Wisconsin, my father, an uncle and myself were surprised to see a striped spermophile (*Citellus tridecemlineatus tridecemlineatus*) scurrying about in the grass near his burrow on one of the fairways. He looked rather "thick" and was undoubtedly very fat. My aim with a mashie was poor and he darted into his hole. On subsequent daily trips to the golf course during the holiday vacation, before the snow finally came on New Year's Day, I failed to see him again. The entire fall had been unusually mild at Green Bay, the average temperature, according to the government weather bureau for November having been 43.2°F., and for December 32°F. The week preceding Christmas Day was especially warm, the temperature on several occasions being near 40°F.

Green Bay is near the northern limit of the species' range in the midwest. Although this limit, in Wisconsin, is said usually to lie in the central part of the state, striped spermophiles have been exceedingly numerous around Green Bay for many years. I have specimens taken 80 miles north of Green Bay, in Marinette county, the most northerly county in eastern Wisconsin, where they are very common in the cut-over and burnt-over fields. The rapidity with which these spermophiles extend their range is well known; in Wisconsin they apparently have travelled immediately behind the lumberman, following the receding timber-line northward.—WILLIAM L. ENGELS, *University of Notre Dame, Notre Dame, Ind.*

ABERT SQUIRREL BURYING PINE CONES

The two forms of the gray squirrel occupying opposite sides of the Grand Canyon—the black-bellied, white-tailed Kaibab squirrel of the north side and the white-bellied, gray- and white-tailed Abert squirrel of the south side—attract the attention of all visitors interested in wild life, as well as philosophic students of geology and evolution.

An illustration of an interesting economic habit, showing the relation of the Abert to the reproduction of the forest was stumbled on when I was walking through the woods at Grand Canyon, August 29, 1929.

A commotion among the pygmy nuthatches and other small birds attracted my attention to a large yellow pine that dominated its fellows. As I looked to see what was the trouble an Abert squirrel climbed the trunk to its high branches, cut off one of the green cones, and started back down the tree, when to my surprise it was flown at and chased down by an excited Mearns's woodpecker. The cause of the onslaught was explained later as proprietary, for the old trunk was riddled with the small storage holes of woodpeckers.

At the foot of the tree the squirrel started off across the stony ground. Curious to see where it could find a place soft enough to dig a hole, I followed. Once it stopped and apparently tested the ground; then went on up the slope. Finally it found a better place, and leaning down, steadying itself with hind feet wide apart, its white-backed brush curved up at its back, it dug hard for a few seconds; then patted down the earth and went away. A green plant that I lined between tree trunks led me to the spot. Here I found a patch of smooth soft earth the width of a hand that had been washed down among the stones by recent heavy rains. Yes, the earth was freshly disturbed, and old brown pine needles lay criss-cross over it. This must be the cache. And so it proved, for close beneath the surface I came to a bright green cone about three inches long lying horizontally in its brown bed.

Returning to watch the tree, before long I saw a squirrel, perhaps the one I had followed to its cache, come down the trunk with a green cone in its mouth—held by the small end—and go off out of sight in another direction to bury it. By this time three Abert's squirrels were running around under the pines, one apparently not full grown frisking about playfully. One of the adults in coming up the slope to the foot of the big tree saw me and started up the back of the trunk but soon sidled around in sight, whipping its tail up and down. Then, climbing to a horizontal branch near enough for me to see its eye, it looked down at me, stamped one foot, whipped its tail, and went on up. After an interval, subdued barking came from overhead. Raising my glass, I made out a furry

form near the top of the tree on a level branch, stretched out full length as if resting. As I watched it got up, cut off a cone, bit off a few of the scales that hid the rich nutty seeds and then stopped for another rest, after which it rolled the cone with its paws and cut off a few more scales. While it was doing this a second Abert climbed to a high branch, got a cone and had a good lunch.

Then, ready for work, one of the handsome fellows came hurrying down the trunk with a green cone in its mouth—held by the large end, I noted, this time. Instead of going up the slope it ran down the slope nearly to the foot of a pine where I later found a deer bed. As it dug its hole it stood facing me and with the glass I could see the green cone held in its mouth and its white-lined gray front legs digging fast. When the cone was safely in its resting place I saw its legs rapidly crossing and recrossing with their familiar covering up and patting down motions.

Going down the slope I tried to find the place, but the wash had been heavy here, leaving a thick drift of old pine needles, and without a green plant to mark the spot it was too well concealed to be discovered. But I had learned that Abert does bury its cones some rods from the parent tree, and so serves as a good seed distributor and tree planter.

Going for a last look at the yellow pine, I found two squirrels in its top and this time there was a noisy chase down, as if the territorial instinct was asserting itself and a poacher was being driven off, for fear there would not be enough cones for all.—Florence Merriam Bailey, *Washington, D. C.*

NOTES ON RANGE OF THE EASTERN CHIPMUNKS IN OHIO, INDIANA, AND QUEBEC

Through an unfortunate error the map of the distribution of the eastern chipmunks published on page 15 of my revision (North American Fauna No. 52) does not agree with certain statements in the text. The range of *Tamias striatus griseus*, as indicated on the map, includes the greater part of Indiana, while in the text specimens from numerous localities in the State are referred to *striatus*.

Through the courtesy of the custodians of the collections in the University of Michigan, the University of Notre Dame, the American Museum of Natural History, the Museum of Comparative Zoology, and the Field Museum of Natural History, I have been able to assemble about 50 specimens of *Tamias* from Ohio, Indiana, and southwestern Michigan. With this material in hand it is clear that most of the specimens are referable to *Tamias s. fisheri*, the range of which is found to cover the greater part of Ohio and Indiana and the extreme southwest corner of Michigan. *Tamias s. griseus* reaches only the extreme west-central part of Indiana. The localities from which specimens have lately been examined are as follows:

Tamias striatus fisheri

Ohio: Athens, 1; Avondale, 1; Bowerston, 2; Carpenter, 1; Fairfield County, 1; Garrettsville, 6; Loudenville, 3; Maysville, 1; Overton, 1; Ravenna, 6; Wooster, 3.

Indiana: Boone County, 2; Dearborn County, 5; Denver, 2; LaPorte, 1; Miami County, 3; Notre Dame, 9; Salamonia, 1.

Michigan: Warren Woods, Berrien County, 2.

Tamias striatus griseus

INDIANA: Parke County, 3.

The map already referred to shows the range of *Tamias s. lysteri* as covering the Gaspe Peninsula, Quebec, while in the text specimens from Cascapedia River and St. Anne des Monts are referred to *griseus* and those from Percé to *lysteri*. Further study shows that *all* specimens from this peninsula, although they are clearly intermediate between *griseus* and *lysteri*, would better be referred to *griseus*.—ARTHUR H. HOWELL, *U. S. Biological Survey*.

OCCURRENCE OF THE SHORT-TAILED MEADOW MOUSE IN NORTHERN CALIFORNIA

On October 21, 1931 the writer secured a short-tailed meadow mouse, presumably a subspecies of *Lagurus curtatus*, on the Madeline Plains, six miles east of Ravendale, Lassen County, California. It was taken in an area where sagebrush (*Artemisia tridentata*) and rabbit-brush (*Chrysothamnus nauseosus*) grew. Bushes of the former averaged approximately four feet in height and were slightly matted with old leaves at their bases. Continued trapping for several nights in this locality resulted in failure to catch any more of these mice.

This is a new record for northern California. The only other points in the state where this species has been taken are in Mono and Inyo Counties; the most northern locality being Mono Mills, Mono County, over two hundred miles south of the Madeline Plains. The nearest subspecies, geographically, is *Lagurus c. artemisiae*, which occurs in southeastern Oregon.

The specimen is an immature female, measuring in millimeters as follows: Total length, 102; tail vertebrae, 19; hind foot, 17; ear from notch, 8.5. In color it is a darker gray than any skins of *Lagurus curtatus* or *Lagurus intermedius* of a nearly corresponding age in the collection of the California Museum of Vertebrate Zoology. However, more material will have to be obtained before its systematic position can be determined.—ROBERT T. ORR, *Museum of Vertebrate Zoology, University of California, Berkeley, California*.

THE VOICE OF THE PORCUPINE

Two writers, Mr. Charles Foster Batchelder and Mr. Otis Wade (Journal of Mammalogy, May, 1930, pp. 237–239, and Feb., 1931, p. 71) have recently contributed notes on the voice of the porcupine. My experience in the summer of 1930 seems to add something that is worthy of note.

On July 16, 1930, I was proceeding up the valley of Stony Brook in the Allegany State Park, New York, engaged on research work in ornithology for the New York State Museum. Ahead of me I heard a sound that was new. I was already acquainted with low grunting and whining noises made by porcupines, but this sound was so different that I had not the slightest idea what sort of creature produced it. The sound continued at intervals and I soon traced it to its source in the top of a large sugar maple. Two full-grown porcupines were in the tree, and facing each other about eight feet apart. One sat still, but the other kept climbing about from one branch to another, apparently seeking to get near the first, but unable to do so because of the small size of the branches. It was apparently only this second animal that produced the sound.

The sound that first attracted my attention was evidently much louder than

that described by the other observers, for I estimated that the distance from which I first heard it was about 200 yards. The animal was keeping up a continual series of whining noises, most of them not loud; but every few minutes it would suddenly burst out into a loud, long harsh wail that first rose and then fell in pitch, and seemed like an expression of uncontrollable anger. After two or three such outbursts it would calm down to a softer whining for a time, and then burst out afresh. The whole performance was strongly suggestive of the sound of a nocturnal cat fight, but the voice was harsher on the louder parts than any cat I ever heard. The softer parts were rather like the impatient whining of a dog.

I sat for some time under the tree watching the performance and taking notes. The animals paid no attention to me, nor to a long-eared owl that I later discovered was seated on a stub behind me. Apparently the owl was also attracted by the sound, and was silently adding to its store of wisdom, though whether more interested in the porcupines or the naturalist and his note-book I cannot say.

When I finally left I continued to hear the louder sounds till I was about 200 yards away. This was about 10 o'clock in the morning on a bright sunny day. So it seems that under the right conditions a porcupine may lift up its voice in the daytime.

I am inclined to think that one of the porcupines had either chased the other up the tree, or had climbed the tree and become angry at finding the other there. It is of course possible that this was a courtship, but the voice certainly suggested anger and defiance. In an animal with so strange a character as the porcupine it is difficult to determine just what are the emotions it attempts to express.—Aretas A. Saunders, *Fairfield, Conn.*

The Song of the Porcupine (Erethizon epixanthum)

On the evening of June 25, 1931, I and my family encountered a porcupine galloping across the half-open land of my ranch. We gave chase. It took refuge under some bushes, and began its usual tail-switching maneuvers. We had little difficulty in catching it with a forked stick and a wire noose; we then dumped the creature into a keg. It proved a female, recently nursing, but now apparently dry.

A large wire cage was made next day, and the porcupine supplied with every essential of porky joy, except absolute freedom. From this on, she was closely observed. First, I noticed that in climbing the side of the cage she used her tail exactly as a woodpecker does, its sharp underquills gripping the wall or the wire, and furnishing a good additional support. Next, I learned, with regret, that her notions of sanitation consisted chiefly in taking a good drink of water, then turning around to deliberately defecate in the water trough.

But her chief contribution to quill-pig lore was secured in November. Mr. E. G. Buttree, who manages my zoo, said to me one day, early in the month: "There is a new owl about. I hear him every night around the zoo. It is not the hoot of the horned owl, but is evidently an owl call." As the month went on, the owl was heard more and more often. Then, one evening, the whole family went out to listen. By creeping up, we got close, and eventually determined that, without a doubt, the strange owl hoot came from the porcupine.

At first we heard it only by night, but later by day. And we learned that by making a careful imitation we could induce the porky to respond with the full

song. Eventually, the porky would respond at almost any time while we sat some 10 feet away and watched the performance.

The first note of the song was much like the hoot of a horned owl, but pitched much higher; beginning on a high note, it went down the scale in half tones, the later ones being sometimes doubled, and all had a faint slur in them. The song may be thus rendered:

Hoo
Hoo hoo hoo
hoo hoo
hoo hoo
hoo hoo hoo
hoo-ho
hoo-ho
hoo-ho

It was clear and owl-like, quite musical, and rather mournful. I have heard a vast number and variety of squeaks, grunts, and wails from porcupines; but this is the first time that I have actually heard it sing. Probably it is a mating song, because the creature was nearly always ready to respond. *When* the porky mating time is, I don't know for sure; but I do know that after singing all through November, she ceased, and since then has not been heard.—Ernest Thompson Seton, *Santa Fe, New Mexico.*

RABBITS KILLED ON AN IDAHO HIGHWAY

In the summers of 1929 and 1931 I travelled on highway No. 40 across Idaho. Both times I made counts of the mammal carcasses per mile seen along the road. Most of these were jack rabbits killed by passing automobiles, but a few were spermophiles struck while feeding on recently killed animals. In the counts no discrimination was made between the two, since at our speed of travel it was often impossible to tell the difference between a ground squirrel and the badly mashed remnant of a rabbit. Both years counts were made along the sagebrush-bordered stretches only and were stopped as soon as cultivated areas were reached.

In 1929, high counts ran to 6, 8, or 10 carcasses per mile for short stretches, but the average was barely over 2 per mile. In 1931, only one stretch gave a count as low as 2 per mile. Most gave averages around 8 or 12, and two stretches as high as 15 and 16 per mile. But the prize stretch was a short one where the rather winding road passes the Thousand Springs. Here I counted as fast as I could, but missed out on a few, and estimated that the carcasses ran very close to 100 per mile for two to three miles.

It would be interesting to see how such counts would compare over a considerable series of years, and whether there would be any indication of cycles in the numbers of animals killed. 1931 has been a year of rodent abundance in many parts of the West, and in Idaho the carcasses were certainly far more common along the road than in 1929.—Kenneth Gordon, *Oregon State College, Corvallis, Oregon.*

STATUS OF EPIACERATHERIUM (RHINOCEROTIDAE)

The appearance of Dal Piaz's important monograph on the excellent Venetian Oligocene rhinoceros material (I Mammiferi dell'Oligocene Veneto. *Trigonias*

ombonii. Mem. Istituto Geol. Univ. Padova, vol. 9, pp. 1–63, pls. I–XX, 1930) necessitates a note of correction to the nomenclature employed in his paper, as well as to that used on pages 417, 418, and 427 of Wood, 1931 (Lower Oligocene Rhinoceroses of the Genus *Trigonias*. Journ. Mammalogy, vol. 12, pp. 414–428). It seems desirable to indicate these changes before the incorrect terminology has become established in the literature. Dal Piaz's *Trigonias ombonii* (1930) is an objective synonym of *Epiaceratherium bolcense* Abel, 1910. Dal Piaz's substitution of the specific name "*ombonii*" (Fabiani, 1915) for "*bolcense*," on the ground that "*bolcense*" is derived from Monte Bolca, an incorrect locality reference, is expressly forbidden by Article 32 of the "International Rules of Zoological Nomenclature," and an earlier use "in litteris" (1911) has no standing, aside from the fact of its following, and not preceding, Abel's name (1910). The generic reference is a matter of judgment. Dal Piaz has shown that *E. bolcense* is more like *Trigonias* than I had realized. However, when I saw his material at Padua, in 1927, just after completing a revision of the genus *Trigonias*, as then known, I did not consider them congeneric. I am still of the same opinion.

The following characters separate *Epiaceratherium bolcense* from any member of the genus *Trigonias:* I^1 is proportionately smaller, simpler, and more incisiform than is known elsewhere in the Rhinocerotidae. (The incisors of *Prohyracodon* and *Eotrigonias* are unknown.) I observed this in Padua; and Dal Piaz's plate 13, figs. 13–16, fully confirms this observation. Dal Piaz gives the antero-posterior measurement as 15.0 mm., which is only three-fifths of the 25.0 mm. of *Trigonias osborni*, although the animal is not much smaller than the smallest individuals of *Trigonias*. In this respect, Dal Piaz's restoration (page 11) appears to be influenced, by published figures of *Trigonias*, away from his own specimens. The unusually large I_1, as compared with I_2, is another distinctive character of *Epiaceratherium*, more primitive than is known elsewhere, and is in consonance with the small primitive I^1. The upper premolars are rather more primitive than in any known species of *Trigonias*. The protocones of the upper molars are set off from the protoconules only moderately, in the "American style," but rather more than in *Trigonias*. *E. bolcense* is somewhat smaller than any known *Trigonias*; Dal Piaz's plate 8, figs. 1–2, makes them appear more nearly of a size by the enlargement of fig. 1 and the reduction of fig. 2. Even in these figures, the *Trigonias* teeth (especially M^{1-2}) are markedly larger. Metacarpal V is more reduced in *Epiaceratherium bolcense* than in *Trigonias*, and the metacarpals are shorter and more stubby, indicating a less cursorial form. Everything considered, it seems definitely preferable to retain their distinct generic status, particularly to avoid sweeping and unjustifiably exact intercontinental correlations. The undoubted resemblances presumably point back toward a common Eocene ancestry for all the Rhinocerotidae.

On the other hand, Dal Piaz has proved that *Epiaceratherium turgaicum* Borissiak is not congeneric with *E. bolcense*, the genotype. His data also disprove my reference to the genus of "*Ronzotherium*" *gaudryi* Rames, Stehlin's *Engyodon* sp., Roman's specimens referred to *Eggysodon osborni* (Schlosser), and *Eggysodon pomeli* Roman, and remove any justification for my proposed new subfamily Epiaceratheriinae, as such. As the forms listed above are now without any valid generic resting-place, I propose the new genus **Allacerops** (from ἄλλος, different,

+ a privative + κέρας, horn, + ὤψ, face), with *Epiaceratherium turgaicum* Borissiak (= *Allacerops turgaica*), the best documented form, as the type species, and also including in the genus *Aceratherium gaudryi* Rames (to which Stehlin's *Engyodon* sp is provisionally referred), **Allacerops osborniana,** new specific name, based on the maxillary in the Montauban Museum, which was referred to *Eggysodon osborni* in Roman, 1911 (Les Rhinocéridés de l'Oligocène d'Europe. Arch. Mus. Hist. nat. Lyon, vol. 11, pp. 11–13, pl. I), and *Eggysodon pomeli* Roman (1911). The subfamily **Allaceropinae** is here proposed, defined by the presence of canine tusks (possibly I‡), as in the Amynodontidae, associated with characters of the cheek teeth and body which are typical, in all other respects, of the true rhinoceroses (Rhinocerotidae). That this group does not belong in the Hyracodontidae is indicated by the much less cursorial limbs, the entirely different shape of the canines, by the cheek teeth, which are rhinocerotid and not hyracodont, and by numerous other characters.—Horace Elmer Wood, 2nd., *Washington Square College, New York University.*

KILLER WHALE IN SLOUGH AT PORTLAND, OREGON

A killer whale (*Orcinus rectipinna*) ascended the Columbia River to the Oregon Slough, a branch of Portland harbor, 110 miles inland from the Pacific Ocean. This whale, first discovered October 12, 1931, disported between the railroad and Pacific Highway bridges, which span the Oregon Slough one nautical mile apart. This slough is the southerly branch of the Columbia River as divided by Hayden island opposite Vancouver, Washington, and is a quarter of a mile wide and twenty to thirty feet deep. Between the date of its arrival and its death, this whale continued to swim between the bridges, rising to blow with remarkable regularity three times and then remaining under an extended period. On rising to the surface it usually showed only its dorsal fin and a portion of the back. Seldom, if ever, was the tail shown, as in the case of deep sea soundings. So far as known, it never ventured beyond the space between the bridges. Thousands of school children and adults viewed the spectacle, but as little could be seen of the visitor, accurate classification was impossible. The creature seemed to be conscious of the attraction it was creating and on occasion disported itself as though playing hide and seek. It seemed to procure ample food supply, doubtless from the fact that the Swift Packing Plant drains into the water of its selected habitat and this attracts large quantities of carp and other fish upon which it could feed abundantly.

Strange as it may seem this playful and interesting creature aroused the killer instinct in some wanton persons who first sought to slay it with high powered rifles and finally on October 24 the poor creature was attacked by two boatmen and done to death with harpoon and spear. We omit report of the indignation of the public, and the earnest efforts of the District Attorney and Sheriff of Multnomah County to bring the culprits to justice, except to express regret that their good efforts were ultimately in vain.

Measurements.—The specimen herein referred to was a female, thirteen and a half feet in straight line from tip to tip, and in circumference at points, measured in inches from snout as follows:

	Circumference
At 18 inches (at angle of mouth)	5 feet 5 inches
At 21 inches	5 feet 11 inches
At 33 inches (at level of pectoral fin)	6 feet 8 inches
At 45 inches	6 feet 9 inches
At 57 inches	7 feet 2 inches
At 65 inches	7 feet 2 inches
At 81 inches	6 feet 8 inches

Dorsal Fin.—Begins six feet, one inch from forward end of upper jaw or "snout;" slightly falcated, 18 inches high; forward edge to top, 20 inches; diameter of base, 18 inches.

Spiracle or "Blow Hole."—On top of head, 21 inches from snout, with diameter of 3 inches.

Eyes.—20 inches from snout, slightly above and behind the outer limit of the mouth on either side.

Pectoral Fins.—One on either side, beginning 33 inches from snout, oval shaped, black in color, and 23 inches in greatest measurement.

Teeth.—Twelve on each jaw, 48 in all. The first tooth is small and blunt, the others are sharp and strong with something of an after-rake, and average more than one inch in length in the clear, and two inches in circumference.

Tail.—Two horizontal flukes begin 11 feet, 7 inches from snout and extend to outer tips 34 inches apart, with 7 inch concave between tips. Lower side white and upper black. From dorsal fin to the flukes of the tail the body tapers gradually.

Color.—Upper part of body black but giving way to white on all of under part. Below mouth and following an arc to base of pectoral fin, all white. A white patch 20 inches from snout and just above eye, 23 inches long, runs parallel to median line, another area of white, 7 inches wide, extends upward from belly and then backward to a point 9 feet and 4 inches from snout.

Weight.—Not weighed but estimated at 1860 pounds on basis of above measurements.—GEORGE S. SHEPHERD, *Portland, Oregon.*

RECENT LITERATURE

Jacobi, Arnold. DAS RENTIER, ERGÄNZUNGSBAND ZUM ZOOLOGISCHEN ANZEIGER, Band 96, pp. VII, 264, figs. 32, pls. 6. Akademische Verlagsgesellschaft m. b. H., Leipzig, November, 1931. Paper, 22 marks.

A very useful and much needed general review of the Reindeer is now presented by Dr. Jacobi of Dresden, Professor at the Technische Hochschule and Director of the Museums of Zoology and Anthropology. This book is the result of nearly thirty years' study of material in the museums of Germany, Scandinavia and Russia, and of two winter expeditions in the polar zone.

Eighteen forms of living reindeer are recognized. The following names that have appeared in recent literature are thrown into synonymy: *sibiricus* Schreber = *tarandus* Linnaeus, *spetsbergensis* Andersén = *platyrhynchus* Vrolik, *granti* Allen = *arcticus* Richardson, *mcguirei* Figgins = *stonei* Allen, *ogilvyensis* Millais = *osborni* Allen. One race is described as new: *Rangifer arcticus asiaticus* (p. 85).

Of particular importance is the distribution assigned to the two groups of barren ground reindeer as illustrated by the map on page 83 (fig. 19). The range of the *tarandus* group is there shown to extend from the west coast of Greenland eastward nearly to the Lena River, including Spitzbergen and Nova Zembla. In Siberia it ends along an almost straight north-south line running from the Gulf of Khatanga to the west side of Lake Baikal. South of lat. 65° there are no reindeer in the territory lying immediately east of this line, but, in the region extending from lat. 65° northward to the coast, the range of *R. tarandus* comes into abrupt contact with that of *R. arcticus*. Thence westward the *arcticus* group ranges across the tundras of Asia and North America to the islands west of Baffin Bay and Smith Sound. Southward extensions of these ranges occur in the mountains of Scandinavia and of western North America. That an animal nearly related to the American barren ground reindeer should occur in eastern Asia is not a matter to cause any surprise; that the western border of its range should have exactly the simple form indicated by Dr. Jacobi would seem, however, to require confirmation.

Decidedly unexpected is the author's conclusion that the extinct reindeer of central Europe was not a form of *Rangifer tarandus* but an animal of the American barren ground type. Whether it should be referred to *Rangifer arcticus* or to *R. caboti* is a question whose answer must await the discovery of more skulls than are now available for study; but the numerous well preserved antlers that have been collected, and likewise the drawings left by prehistoric men, all point to the conclusion that the Pleistocene European reindeer was a member of the *arcticus* group.

If Dr. Jacobi's exposition of these facts is reasonably convincing the same cannot be said of his attempt to explain them. This he would do by bringing the American animal into Europe from the west, at the peak of the glacial period, when, according to Wegener's hypothesis of continental drift, Greenland, northeastern North America and the land mass from which the present outlines of western Europe have been carved were solidly united. To the development of this thesis he devotes nearly six pages (103–108) illustrated by three maps (figs. 21–23). As an example of the fascination that Wegener's generalizations exercise

on many minds these pages are instructive. As a contribution to zoogeography they are not convincing, because a valid argument for a direct American origin of the European Pleistocene reindeer would have to be founded on the positive identification of the European remains as American and not Asiatic in type. Dr. Jacobi, it is true, expressly states on page 101 that "in reality the fossil [European] antlers, so far as their condition permits a determination, *belong to the American tundra reindeer*" (italics his). But, on page 85, he had already said that the antlers of the East Siberian *Rangifer arcticus asiaticus* "differ is no essential from those of [the American] *R. arcticus arcticus*." In other words, the only recognized differences between the Asiatic and American forms of *Rangifer arcticus* being peculiarities in color it is now impossible to determine whether the European Pleistocene animal was more like the one than the other. Therefore the most that can be actually known is the apparent existence in Europe, during the Pleistocene, of a type of reindeer that is now confined to a more easterly range extending from eastern Asia into North America. But this kind of distribution is not unique. Conspicuous examples of essentially the same sort are furnished, for instance, by the past and present distribution of the "cave" bears, of the microtine rodents of the "*Stenocranius*" type, and of the lagomorphs of the genus *Ochotona*. All of these mammals, whose range is now restricted to parts of Asia and western North America, formerly inhabited western Europe, and there is no reason to suppose that they arrived there by reason of direct contact of Europe with Labrador. Since the time of their greatest westward extension during the Pleistocene all of them appear to have suffered progressive dying out from west to east. It is not unreasonable to suppose that the *arcticus* reindeer have had a similar fate. Certainly Dr. Jacobi has not brought forward any convincing evidence to prove that the history of these animals has been so radically peculiar as to need great continental earth movements to explain it.

Not the least interesting part of the book is the chapter on Life History, in which the reindeer's fondness for such seemingly strange food as fish, lemmings, and poisonous fungi is fully described. The many figures in the plates present a remarkable series of reindeer antlers. There is an index; also a bibliography filling eleven pages.—GERRIT S. MILLER, JR.

AAGAARD, B. Antarctic whaling and exploration. Scottish Geogr. Mag. Edinburgh, vol. 45, no. 1, pp. 23–34, 65–81, illus. January-March, 1929.

ABEL, O. Plastische Rekonstruktion des Lebensbildes von *Bunolophodon angustidens*. Palaeobiol. Wien, vol. 1, pp. 482–486, 2 pls. 1928.

——— Das Skelett der Eurhinodelphiden aus dem Oberen Miozän von Antwerpen. III. Teil und Schluss der "Dauphins longirostres du Boldérien [Miocène supérieur] des environs d'Anvers." Mém. Mus. Roy. Hist. Nat. Belgique, Bruxelles, Mém. 48, pp. 191–334, pls. 19–29. 1931.

ABUREL, E. Contribution à l'anatomie du bassin de la *Talpa europaea* L. Bull. Mus. Hist. Nat. Paris, ser. 2, vol. 1, no. 5, pp. 292–297, figs. 2. June, 1929.

ANTHONY, H. E. Camping in a prehistoric forest. Nat. Hist., vol. 30, no. 4, pp. 367–376, illus. July–August, 1930. (Short account of mammals.)

——— Southern Asia in the American Museum. Nat. Hist., vol. 30, no. 6, pp. 577–592, illus. November-December, 1930.

ANTHONY, R. Discussion sur l'interprétation de la série dentaire inférieure du Stehlinius uintahensis Matth. Bull. Mus. Nat. Hist. Nat., Paris, 1928, no. 6, pp. 416–421, figs. 2. 1928.

ARAMBOURG, C. Les Mammifères quaternaires de l'Algérie. Bull. Soc. Hist. Nat. Afrique du Nord, vol. 20, no. 3, pp. 63–84, pl. 1. 1929.

——— and J. PIVETEAU. Les vertébrés du Pontien de Salonique. Ann. Paléont., Paris, vol. 18, nos. 2–3, pp. 3–82, figs. 8, pls. 12. October, 1929. (New: *Dorcatherium puyhauberti; Gazella bailloudi; Parabos macedoniae.*)

ARCHBOLD, RICHARD. Bevato—a camp in Madagascar. Experiences of a collector in an island forest. Nat. Hist., vol. 30, no. 6, pp. 645–652. November–December, 1930.

ASHBROOK, FRANK G. Rabbit raising in the United States. Verhandl. des. I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 146–151. 1931.

ASTRE, GASTON. Anthracotherium magnum à Saint-Nazaire-de-Valentane. Bull. Soc. Hist. Nat. Toulouse, vol. 59, no. 1, pp. 153–154. 1930.

BABAULT, GUY. Note sur la biologie et l'habitat du Gorille de Béringé. Rev. Française Mammal., ser. 1, no. 2, pp. 61–63, pl. 1. December 7, 1928.

BARBOUR, E. H. Amebelodon sinclairi sp. nov. Nebraska State Mus., vol. 1, bull. 17, pp. 155–158, fig. 101. January, 1930, (New: *Amebelodon sinclairi.*)

——— The mandible of Amebelodon fricki. Nebraska State Mus., vol. 1, bull. 15, pp. 139–146, figs. 93–97. December, 1929.

——— A new Amebelodont, Torynobelodon barnumbrowni, sp. nov. A preliminary report. Nebraska State Mus., vol. 1, bull. 22, pp. 191–198, figs. 123–126. August, 1931. (New: *Torynobelodon; T. barnumbrowni.*)

BATTYE, R. K. M. Malformation in skull of a thar (*Hemitragus jemlaicus*). Journ. Bombay Nat. Hist. Soc., vol. 34, no. 4, pp. 1057–1058. March 2, 1931.

BOBRINSKOY, N. Vertebrate fauna of Russian Turkestan, its investigations and actual problems. Proc. Sci. Invest. Institute of Zoology, Moscou, vol. 3, no. 2, pp. 1–137, map. 1929. (In Russian, with English summary.)

BRANDES, G. Noch einmal zum Heranwachsen des Gorilla. Zool. Garten, n.F., vol. 3, nos. 4–8, pp. 222–223. August 11, 1930.

——— Gorillas im Zoo Zürich und Schönbrunn. Zool. Garten, n.F., vol. 4, nos. 6–7, p. 246. July, 1931.

BROOM, R. On some recent new light on the origin of mammals. Proc. Linnean Soc. N.S.W., vol. 54, pt. 5, pp. 688–694. 1929.

BÜCKMANN, A. Zur Biologie der Wale. Zool. Garten, n.F., vol. 3, nos. 4–8, pp. 221–222. August 11, 1930.

BURNETT, W. L. Life history studies of the Wyoming ground squirrel (Citellus elegans elegans) in Colorado. Colorado Agric. College Bull. 373, pp. 23, figs. 7, 1931.

CABRERA, A. A propósito de la Biología de los Xenartros. Real Soc. Española Hist. Nat., vol. 4, no. 3, pp. 123–126. 1929.

CHAWORTH-MUSTERS, J. L. Some notes on the Norwegian finwhales. Det Kgl. Norske Videnskabers Selskabs Skrifter 1931, Trondheim, no. 4, pp. 1–10. 1931.

COLYER, FRANK. Abnormal tusks of elephants. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 694–699. November 15, 1930.

DAGLISH, E. F. The life story of beasts. New York, pp. 219, illus. 1931. ("The author is an artist as well as a naturalist. His illustrations are striking, and his text presents a wide variety of facts, including many curious ones, about mammals. The book is in the same style as the author's The life story of birds.")

DIETRICH, W. O. Neue Nashornreste aus Schwaben (Diaceratherium tomerdingensis n.g. n.sp.) Zeitschrift für Säugetierkunde, Berlin, vol. 6, no. 5, pp. 203–220, figs. 15, pls. 22–23. December 15, 1931. (New: *Diaceratherium tomerdingensis*.)

DUERDEN, J. E. Seasonal variation in the coat of some domestic mammals. South African Journ. Sci. vol. 27, pp. 521–545. November, 1930.

DUNCKER, G. Die Zukunft der grönländischen Moschusochsen. Zool. Garten, n.F., vol. 3, nos. 4–8, pp. 219–221, figs. 1–2. August 11, 1930.

——— Gefangenschaft-Beobachtungen an *Myotis nattereri* Kuhl. Zool. Garten, n.F., vol 4, nos. 1–2, pp. 17–27, figs. 1–4. February, 1931.

FESTA, E. Il Capriolo dell'Italia centrale. Boll. Mus. Zool. ed Anat. Comp. R. Univ., Torino, vol. 40, (paper no. 37), pp. 1–2. 1925 (1926) (New: *Capreolus capreolus italicus*.)

FLEROV, K. K. A trunk of mammoth (Elephas primigenius Blum.) found in the Kolyma District (Siberia). Bull. Acad. Sci. URSS. Cl. sci. math. et nat, pp. 863–870, figs. 4, pls. 1–2. 1931. (In English, with Russian résumé.)

FRY, T. B. Proposed classification of the smaller Indian field (or jungle) mice. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 4, pp. 916–921. March 2, 1931. (New: *Leggada lepidoides*.)

GIDLEY, JAMES W. Further investigations on evidence of early man in Florida. Explorations and field-work of the Smithsonian Institution in 1930, publ. 3111, pp. 41–44, figs. 33–36. March 26, 1931.

GILMORE, CHARLES, W. Fossil hunting in the Bridger Basin of Wyoming. Explorations and field-work of the Smithsonian Institution in 1930, publ. 3111, pp. 13–20, figs. 11–16. March 26, 1931.

GOLDMAN, E. A. A new agouti from Costa Rica. Journ. Washington Acad. Sci., vol. 21, no. 19, p. 481. November 19, 1931. (New: *Dasyprocta punctata underwoodi*.)

GRANDIDIER, G. AND G. PETIT. Description d'une espèce nouvelle d'Insectivore Malgache, suivie de remarques critiques sur le genre *Oryzoryctes*. Bull. Mus. Nat. Hist. Nat., vol. 2, ser. 2, pp. 498–505. June, 1930. (New: *Oryzoryctes talpoides*.)

GRANGER, WALTER. Camp life on the Gobi Desert. Incidents and experiences in the daily lives of the men of the American Museum Central Asiatic expeditions in Mongolia. Nat. Hist., New York, vol. 31, no. 4, pp. 359–373, illus. 1931.

GRAY, ROBERT, W. Spitsbergen whale fishery of the seventeenth century. Nature, London, vol. 126, no. 3171, p. 204. August 9, 1930.

GRIMPE. Die Eisbären-Zucht im Zoo zu Milwaukee. Zool. Garten, n.F., vol. 3, nos. 4–8, pp. 217–218. August 11, 1930.

HAGEDOORN, A. L. Über Leporiden. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 66–69. 1931.

HAMMOND, JOHN. The processes of reproduction in the rabbit. Verhandl. des. I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 56–63. 1931.

HANSON, KARL, B. [Dr. Hanson gives probable results of cross breeding.] Amer. Fur Breeder, vol. 4, no. 1, p. 22. July, 1931.

HARTMAN, C. G., R. R. SQUIER, AND O. L. TINKLEPAUGH. The fetal heart rate in the monkey (*Macacus rhesus*.) Proc. Soc. Exper. Biol. and Medicine, vol. 28, pp. 285–288, table. 1930.

HATT, ROBERT, T. Collectors' days and nights in Yucatan. Nat. Hist., vol. 30, no. 6, pp. 617–626. November–December, 1930.

HEDIGER, H. Das problem des Werfens beim Känguruh. Zool. Garten, n.F., vol. 4, nos. 6–7, pp. 244–246. July, 1931.

HEIM DE BALSAC, H. Notes sur la présence et la repartition de quelques grands Mammifères dans le Sud-Oranais et le Maroc oriental. Rev. Française Mammal., ser. 1, no. 2, pp. 83–92. December 7, 1928.

HELBING, H. Zur Definition des Genus Trochictis. Eclogæ Geologicæ Helvetiæ, vol. 20, no. 2, pp. 302–307, figs. 3. 1927.

——— Pseudocyon sansaniensis Lartet von Steinheim am Albuch. Eclogæ Geologicæ Helvetiæ, vol. 22, no. 2, pp. 180–184, figs. 3. 1929.

HELLER, FLORIAN. Eine Forest-Bed-Fauna aus der Sackdillinger Höhle (Oberpfalz). Neues Jahrbuch für Mineral. Geol. und Pälaont., Stuttgart, vol. 63 B. pp. 247–298. 1930. (New: *Sorex praealpinus*; *Sorex araneoides*; *Dolomys lenki*; *Evotomys esperi*; *Myoxus glis* var. *sackdillingensis*.)

HEPTNER, W. G. Notizen über die Gerbillinae (Mammalia, Muridae). III. Zool. Anzeiger, vol. 94, nos. 3–4, pp. 119–122. April 20, 1931 (New: *Meriones rossicus*; *M. bogdanovi*; *M. vinogradovi*.)

——— Materiale zur Kenntnis der geographischen Verbreitung und Biologie des Weisswales (Delphinapterus). Proc. Sci. Invest. Institute of Zoology, Moscou, vol. 4, no. 2, pp. 7–100, figs. 8. 1930. (In Russian.)

HERSCHBACH, B. Über den Stand der Kaninchenzucht im Grossherzogtum Luxembourg. Verhandl. des I. Internat. Kaninchezüchter-Kongresses, Leipzig, 1930, pp. 174–177. 1931.

HINTON, M. A. C. Rats and mice as enemies of mankind. 3rd ed. pp. 70, pls. 2, figs. 6. British Mus. (Nat. Hist.) Econ. ser. 8. 1931.

HOARE, W. H. B. Conserving Canada's musk-oxen. Being an account of an investigation of Thelon Game Sanctuary 1928–29 with a brief history of the area and an outline of known facts regarding the musk-ox. (Appendix B, Notes on the musk-ox and the caribou, by R. M. Anderson, pp. 49–53, 2 maps.) North West Terr. and Yukon Branch, Dept. Interior, Ottawa, pp. 53, illus. 1930. (Received, February 15, 1932).

HOPKINS, H. R. Breaking mink fur. Amer. Fur Breeder, vol. 4, no. 1, p. 32. July, 1931.

HORISBERGER, E. Der Werdegang der Versicherung des Schweizer Kaninchenzuchtverbandes. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 280–283. 1931.

HORSCH, ALFRED, G. On the Vermilion. A moose hunt in the hinterlands of Canada. Outdoor Life, vol. 67, no. 2, pp. 14–15, 78–80. February, 1931.

Howes, Paul Griswold. Wild life in Dominica. Nat. Hist., vol. 30, no. 1, pp. 90–103. January–February. 1930.

Huey, Laurence, M. A new subspecies of *Peromyscus* from the Gulf Coast of Lower California, Mexico. Trans. San Diego Soc. Nat. Hist., vol. 6, no. 26, pp. 389–390. August 28, 1931. (New: *Peromyscus crinitus pallidissimus.*)

——— Two new ground squirrels from Lower California, Mexico. Trans. San Diego Soc. Nat. Hist., vol. 7, no. 2, pp. 17–20. October 6, 1931. (New: *Citellus beecheyi rupinarum; Citellus beecheyi nudipes.*)

Hugues, A. Note sur la Genette en France, *Genetta genetta rhodanica* Matschie. Rev. Française Mammal., ser. 1, no. 2, pp. 52–60. December 7, 1928.

Iljin, N. Wissenschaftliche Arbeiten zur Biologie des Kaninchens in der U.d.S.-S.R. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 161–169. 1931.

Joleaud, L. Le rôle des singes dans les traditions populaires Nord-Africaines. Journ. Soc. Africanistes, Paris, Vol. 1, no. 1, pp. 117–150. 1931.

Keeler, Clyde, E. The laboratory mouse. Its origin, heredity, and culture. Harvard Univ. Press, pp. 81, fig. 36, Cambridge. 1931.

Kellogg, Eugene, S. The California ground squirrel control program. Special Publ. 109, Dept. Agric. State Calif., Sacramento, pp. 21. 1931.

Kellogg, Remington. A miocene long-beaked porpoise from California. Smithsonian Misc. Coll., vol. 87, no. 2, pp. 1–11, pls. 4. January 22, 1932. (New: *Argyrocetus joaquinensis.*)

Koch, W. Das Gehörn der Schraubenziege (*Capra falconeri* Wagn.). Zool. Anzeiger, vol. 93, nos. 7–10, pp. 275–278, figs. 2, March 1, 1931.

Koenigswald, Ralph. Die Tapirreste aus dem Aquitan von Ulm und Mainz. Palaeontographica, Stuttgart, vol. 73, pp. 1–29, fig. 1. 1930. (New: *Tapirus moguntiacus; T. robustus.*)

Kraglievich, Lucas and Carlos Rusconi. Restos de vertebrados vivientes y extinguidos hallados por los señores E. R. Wagner y hermano en túmulos precolombianos de Santiago del Estero. Physis, vol. 10, pp. 229–241. January 30, 1931.

Lataste, F. Les saisons du rut et de la parturition des Martes. Rev. Française Mammal., ser. 1, no. 2, pp. 49–51. December 7, 1928.

Lavauden, L. Essai sur l'origine et l'etymologie des noms des Mammifères de la France. Rev. Française Mammal., ser. 1, no. 2, pp. 64–82. December 7, 1928.

Letard, Etienne. Le Caractère Rex et la Tréponémose du Lapin. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 80–88. 1931.

Leuthardt, F. Ueber eisenzeitliche Knochenreste (Küchenabfälle) von der Sissacherfluh (Baselland). Eclogæ Geologicæ Helvetiæ, vol. 23, no. 2, pp. 588–593. December, 1930.

L'Isle Sturm, G. de. A panther incident. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, p. 798. November 15, 1930.

Lönnberg, Einar. On a case of syndactylous anomaly in a South American deer. Arkiv. för Zoologi, vol. 22 A, no. 8, pp. 1–3, figs. 4. December 19, 1930.

LÖNNBERG, EINAR. The homologies of the incisors of the higher primates in the light of some "Anomalies" in the dentition of gibbons. Arkiv. Zool., Stockholm, vol. 22 A, no. 6, pp. 1–6, figs. 4. December 24, 1930.

——— A remarkable species of *Lagothrix*. Arkiv. Zool., Stockholm, vol. 22 B, no. 2, pp. 1–3. February 4, 1931. (New: *Lagothrix caroarensis*.)

LUTTRINGER, LEO, A., JR. An introduction to the mammals of Pennsylvania. Bull. no. 15, issued by the Board of Game Commissioners of Pennsylvania, pp. 66. 1931.

MAINLAND, DONALD. The sizes of ferret pronuclei. Anat. Record, vol. 49, no. 2, pp. 103–120. April, 1931.

——— The measurement of ferret pronuclei. Trans. Roy. Soc. Canada, ser. 3, vol. 25, sect. 5, pp. 33–42. May, 1931.

MAIOCCO, FRANCESCO. L'allevamento del coniglio in Italia e mezzi di diffusione. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 154–159. 1931.

MARCQ, J. L'Elevage du Lapin en Belgique. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 117–120. 1931.

MARWICK, JAMES, G. Long-eared bat in Orkney. Scottish Naturalist, vol. 189, pp. 88–89. May–June, 1931.

MATHESON, COLIN. The brown and the black rat in Wales. Publ. Nat. Mus. Wales and Press Board Univ. Wales, Cardiff, pp. vii+ 46, pls. 5. 1931.

MATTHEW, W. D. Genera and new species of ground sloths from the Pleistocene of Cuba. [Prefatory note by Walter Granger.] Amer. Mus. Nov. no. 511, pp. 1–5. December 15, 1931. (New: *Mesocnus browni; M. torrei; Miocnus antillensis*.)

MCCLINTOCK, MOLLIE L. A mink nursery. Amer. Fur Breeder, vol. 4, no. 1, pp. 21–22. July, 1931.

MCGUIRE, HARRY. The status of the bear. Outdoor Life, vol. 67, no. 3, pp. 16–17, 56–58. March, 1931.

MEYN, A. Infektionskrankheiten beim Kaninchen. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 243–253. 1931.

MIRANDA-RIBEIRO, ALIPIO DE. Reivindicacão do Genero Carolibergia de Mercerat. Archiv. Mus. Nacion., Rio de Janeiro, vol. 29, pp. 9–20, pls. 4. 1927. (New: *Carolibergia derbyi*.)

MOHR, ERNA. Die Säugetiere Schleswig-Holsteins. Altona-Elbe, pp. 136, figs. 74. 1931.

——— Über Ratten und Rattenbekämpfung. Zool. Garten, n.F., vol. 4, nos. 1–2, pp. 65–66. February, 1931.

——— Wildlebende Säugetiere in der Umgebung Altonas. (Der Aufsatz berücksichtigt auch den Kreis Pinneberg.) Vor den Toren der Grossstadt III, pp. 20, illus. 1930.

MONARD, A. Mission Scientifique Suisse dans l'Angola résultats scientifiques. Mammifères. Part, 1. Ongulés. Soc. Neuchateloise Sci. Nat. Bull., vol. 54, (new ser., vol. 3), pp. 73–102, for 1929. 1930. (New: *Ourebia leucopus; Raphicerus campestris bourquii*.)

MONIER-TILMANNE, H. La centralisation et la vente en commun des produits et sous-produits de la cuniculiculture et les résultats obtenus en Belgique par la centralisation. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 123–125. 1931.

MORDEN, WILLIAM J. Saiga antelope and long-haired tiger. Nat. Hist., vol. 30, no. 5, pp. 538–551. September–October, 1930.

MORI, TAMEZO. A new species of Microtus from Korea. Journ. Chosen Nat. Hist. Soc., no. 10, p. 53. 1930. (New: *Microtus kishidai*.)

MORRIS, R. C. Observations on the Indian elephant. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 800–801. November 15, 1930.

——— On distinguishing between males and females and other controversial matters pertaining to the gaur (*Bibos gaurus*.) Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 801–802. November 15, 1930.

——— Panther climbing up to a machan. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 797–798. November 15, 1930.

——— Sounds made by porcupines. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 799–800. November 15, 1930.

MUNRO, T. M. Musquash in Scotland. Scottish Naturalist, vol. 189, pp. 65–70, May–June, 1931.

NACHTSHEIM, HANS. Der Einfluss der Ernährung auf die Entwicklung erblich verschiedener Wurfgeschwister. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 211–217. 1931.

——— Das Rexkaninchen und seine Bedeutung für Pelztierzucht und Rauchwaren-wirtschaft. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 70–79. 1931.

——— Über eine erbliche Nervenkrankheit (Syringomyelie) beim Kaninchen. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 254–259. 1931.

NELSON, E. W. AND E. A. GOLDMAN. A new kinkajou from Mexico. Journ. Washington Acad. Sci., vol. 21, no. 19, p. 482-283. November 19, 1931. (New: *Potos flavus campechensis*.)

——— Six new white-footed mice (Peromyscus maniculatus group), from islands off the Pacific Coast. Journ. Washington Acad. Sci., vol. 21, no. 21, pp. 530–535. December 19, 1931. (New: *Peromyscus maniculatus streatori; P.m. santacruzae; P.m. exterus; P.m. elusus; P.m. martinensis; P.m. dorsalis*.)

OGNEV, S. I. Neue Unterart der Feldmaus aus dem Kaukasus. Ber. Mikrobiol. Staats-Instituts, Rostow-am-Don, no. 9, pp. 163–164. 1929. (New: *Microtus arvalis gudauricus*.)

OSBORN, H. F. AND E. H. COLBERT. The elephant enamel method of measuring Pleistocene time. Also stages in the succession of fossil man and stone age industries. Proc. Amer. Philos. Soc., vol. 70, no. 2, pp. 187–191. 1931.

PARKES, A. S. AND S. ZUCKERMAN. The menstrual cycle of the Primates. Part II. Some effects of oestrin on baboons and macaques. Journ. Anat., Cambridge, vol. 65, pt. 2, pp. 272–276, pls. 1–2. January, 1931.

PARKHURST, RAYMOND T. The organization of rabbit education and investigation in Great Britain. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 51–54. 1931.

PEASE, MICHAEL S. The inheritance of yellow fat in rabbits. Verhandl. des I. Internat. Kaninchenzüchter-Krongresses, Leipzig, 1930, pp. 91–94. 1931.

PETERSON, O. A. Two new species of Agriochœrids. Ann. Carnegie Mus., vol. 20, nos. 3–4, pp. 341–354, pls. 2, figs. 9. 1931. (New: *Diplobunops uintensis; D. ultimus.*)

——— New Mesonychids from the Uinta. Ann. Carnegie Mus., vol. 20, nos. 3–4, pp. 333–339, pls. 2, figs. 4. 1931. (New: *Harpagolestes leotensis; Hessolestes; H. ultimus.*)

——— New species of the genus Teleodus from the upper Uinta of northeastern Utah. Ann. Carnegie Mus., vol. 20, nos. 3–4, pp. 307–312, pls. 4, figs. 2. June, 1931. (New: *Teleodus uintensis.*)

PETIT, MAXIME. L'Elevage industriel du Lapin à Fourrure en France. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 114–116. 1931.

PICKARD, JAMES N. Angora rabbits and angora rabbit wool production in Great Britain. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 96–102. 1931.

PILGRIM, G. E. AND N. K. N. AIYENGAR. The lower canine of an Indian species of Conohyus. Rec. Geol. Surv. India, vol. 61, no. 2, pp. 196–205, pl. 1. 1928.

PINCUS, GREGORY. The transplantation of mouse ovaries into the rat. Anat. Record, vol. 49, no. 1, pp. 97–101. March 25, 1931.

POCOCK, R. I. The lions of Asia. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 638–665, pls. 1–5, 1 map. November 15, 1930.

——— The panthers and ounces of Asia. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 1, pp. 64–82, pls. 1–6. March 1, 1930. (New: *Panthera pardus sindica.*)

——— Some external characters of the sea-otter (*Enhydra lutris*). Proc. Zool. Soc. London, 1928, pt. 4, pp. 983–991, figs. 1–5. January 31, 1929.

——— Some external characters of the giant panda (*Ailuropoda melanoleuca*). Proc. Zool. Soc. London, 1928, pt. 4, pp. 975–981, figs. 1–3. January 31, 1929.

——— The structure of the auditory bulla in the *Procyonidae* and the *Ursidae*, with a note on the bulla of *Hyaena*. Proc. Zool. Soc. London, 1928, pt. 4, pp. 963–974, figs. 1–8. January 31, 1929.

——— The long-tailed macaque monkeys (*Macaca radiata* and *M. sinica*) of southern India and Ceylon. Journ. Bombay Nat. Hist. Soc. vol. 35, no. 2, pp. 276–288. October 15, 1931. (New: *Macaca radiata diluta; Macaca sinica inaurea; Macaca sinica aurifrons.*)

——— The pig-tailed macaques (*Macaca nemestrina*). Journ. Bombay Nat. Hist. Soc., vol. 35, no. 2, pp. 297–311. October 15, 1931. (New: *Macaca nemestrina blythii.*)

POETEREN, N. VAN. Wering en bestrijding van de bisamrat. Tijdschr. Plantenziekten, vol. 36, no. 10, pp. 249–255. 1930.

PORTAL, MAURICE. Pine marten in Wigtownshire. Scottish Naturalist, no. 182. p. 49, March–April, 1930.

PRIEMEL, KURT. "Ipani," die portugiesisch-ostafrikanische Elefantin des Frankfurter Zoo. Zool. Garten, n. F., vol. 3, nos. 9–10, pp. 241–244, figs. 1–4. October, 1930.

PHYTHIAN-ADAMS, E. G. Note on the Malay bear (*Ursus malayanus*). Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 798–799. November 15, 1930.

REA, MARIE E. Report on skeletal remains found at Balloo Bay, Co. Down. Irish Naturalists' Journ., vol. 3, no. 8, pp. 166–170, figs. 3. March, 1931.

REVILLIOD, PIERRE. Sur un Mastodon de Bolivie. Mém. Soc. Paléont. Suisse, vol. 51, pp. 21, figs. 9, pls. 2. 1931. (New: *Teleobunomastodon* for *Mastodon bolivianus*.)

RICHARDSON, E. C. The general position of rabbit breeding in England. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 133–136. 1931.

RITCHIE, JAMES. Distribution of the pigmy hippopotamus. Nature, London, vol. 126, no. 3171, pp. 204–205. August 9, 1930.

RITCHIE, JOHN. Albino mammals and birds in Perthshire Museum. Scottish Naturalist, no. 185, p. 153. September–October, 1930.

ROBERTS, AUSTIN. New forms of South African mammals. Ann. Transvaal Mus., vol. 14, pt. 3, pp. 221–236, pls. 3–8. 1931. (New: *Cercopithecus leucampyx schwarzi; C. aethiops cloetei; Galago moholi bradfieldi; Amblysomus marleyi; Crocidura holobrunneus; Poecilogale albinucha lebombo; P.a. bechuanae; Leptailurus serval hamiltoni; Paracynictis sengaani; Parazerus sponsus tongensis; Claviglis zuluensis; Tatera ruddi tongensis; T. lobengula zuluensis; Otomys karoensis; Dendromus melanotis thorntoni; D.m. capensis; D.m. pretoriae; D. jamesoni pongolensis; Steatomys chiversi; S.c. tongensis; Grammomys tongensis; Thallomys moggi lebomboensis; Aethomys chrysophilus tongensis; Lemniscomys griselda zuluensis.*)

ROGANOV, A. N. Seal hunting on sledges in Dzhambai (Caspian Sea) in the winter of 1929. Rept. Astrakhan Sci. Fishery Station, vol. 7, no. 2, pp. 31–68. 1930. (In Russian.)

——— Spring seal hunting in 1929. Rept. Astrakhan Sci. Fishery Station, vol. 7, no. 2, pp. 69–128. 1930. (In Russian; Economic aspects of seal hunting in Caspian sea.)

ROIGNEAU, MARCELLE. "Top of the world" in Yucatan. Digging for fossil mammals in the land of the Maya. Nat. Hist., vol. 30, no. 3, pp. 267–275. May–June, 1930.

RUSCONI, CARLOS. Dos nuevas especies de mustélidos del piso ensenadense. Anales Sociedad Científica Argentina, Buenos Aires, vol. 113, pp. 42–45, figs. 2. January, 1932. (New: *Grisonella hennigi; Conepatus mercedensis praecursor.*)

——— Las especies fósiles del género "Ctenomys" con descripción de nuevas especies. Anales Sociedad Científica Argentina, Buenos Aires, vol. 112, pp. 129–163, figs. 12. October, 1931. (New: *Ctenomys latidens orthognathus; C. dasseni; C. dasseni longirostris; C. intermedius; C. intermedius tandilensis; C. magnus.*)

RZĄŚNICKI, ADOLF. Przyczynek do znajomości mieszańców zebr. (Beitrag zur Kenntnis der Zebrahybriden.) Annales Musei Zoologici Polonici, Warszawa, vol. 9, no. 11, pp. 155–160, pls. 14–18. 1931.

ST. LEGER, J. A new golden mole (Chlorotalpa) from Mt. Elgon, Uganda. Ann. & Mag. Nat. Hist., ser. 10, vol. 8, pp. 605–607. December, 1931. (New: *Chlorotalpa fosteri.*)

SAMOFALOV, P. E. Seal-hunting in the Mangishlak region in 1928–29. Rept. Astrakhan Sci. Fishery Sta., vol. 7, no. 2, pp. 3–30. 1930. (In Russian.)

SANFORD, GERTRUDE AND SIDNEY LEGENDRE. In quest of the Queen of Sheba's antelope. I–II. Nat. Hist., vol. 30, no. 1, pp. 17–32. January–February, 1930; vol. 30, no. 2, pp. 161, 176. March–April, 1930.

SCHAEDTLER, F. C. Die Kaninchenzucht Hollands. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 127–132. 1931.

SCHAUB, S. Fossile Sicistinae. Eclogæ Geologicæ Helvetiæ, vol. 23, no. 2, pp. 616–637, figs. 17. December, 1930. (New: *Plesiominthus myarion; P. promyarion; Heterosminthus orientalis.*)

SCHLAIKJER, ERICH MAREN. Description of a new Mesohippus from the White River formation of South Dakota. Proc. New England Zool. Club, vol. 12, pp. 35–36. January 17, 1931. (New: *Mesohippus barbouri.*)

SCHMIDT-HOENSDORF, FRITZ. Seuchenhafte Streptokokkeninfektion bei Meerkatzen. Zool. Garten, n.F., vol. 4, no. 1–2, pp. 43–47. February, 1931.

SCHOPS, PAUL. Die Weltproduktion an Kaninfellen. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 260–279. 1931.

SCHUBART, O. Die nordamerikanischen Seelöwen. Zool. Garten, n.F., vol. 3, nos. 4–8, pp. 173–183, figs. 1–8. August 11, 1930.

SCHWARZ, ERNST. Die Sammlung afrikanischer Säugetiere im Congo-Museum. Ginsterkatzen (Gattung Genetta Oken). Rev. Zool. & Bot. Africaines, vol. 19, no. 2, pp. 275–286. July 30, 1930.

SHERWOOD, WILLIAM E. The ways of Spilogale. Nature Mag., vol. 17, no. 4, p. 224, fig. 2. April, 1931.

SILVER, JAMES. Red-squill powder in rat control. Leaflet 65, U. S. Dept. Agric., Washington, pp. 1–8, figs. 1–2. January, 1931.

SIMPSON, GEORGE GAYLORD. Sea sirens. The strange mammals responsible for the ancient ideas of mermaids. Nat. Hist., vol. 30, no. 1, pp. 40–47. January–February, 1930.

———— Rodent giants. Living gnawing animals from tiny mice to giant capybaras. Nat. Hist., vol. 30, no. 3, pp. 305–313. May–June, 1930.

SLODKEWITSCH, W. Zur Osteologie der Handwurzel von Elasmotherium caucasicum Borissiak. Ann. Soc. Paléont. Russie, vol. 8, pp. 83–90, 1 pl., (1928–29). 1930.

SLYPER, E. J. Über Verletzungen und Erkrankungen der Wirbelsäule und Rippen bei den Cetaceen. Anat. Anz., vol. 71, nos. 7–9, pp. 156–185, figs. 17. January 24, 1931.

SMITH, G. ELLIOT. Validity of the genus *Sinanthropus*. Nature, London, vol. 127, no. 3200, pp. 304–305. February 28, 1931.

SODY, H. J. V. Over *Rattus rattus roquei* Sody met beschrijving van een nieuw ras van *Rattus rattus* van Soemba. Zool. Mededeel., Leiden, vol. 13, nos. 1–2, pp. 94–99. August 15, 1930. (New: *Rattus rattus sumbae.*)

———— Overzicht van de ratten van Java met beschrijving van een nieuwe subspecies. Zool. Mededeel., Leiden, vol. 13, nos. 1–2, pp. 100–140. August 15, 1930. (New: *Rattus rajah verbeeki.*)

SODY, H. J. V. Twee zoogdierlijsten van Java. Natuurk. Tijdschrift Ned.—Indie, vol. 90, pp. 274–289. 1930.

——— On some new or insufficiently known mammals from Java, Borneo and Celebes. Natuurk. Tijdschrift Ned.—Indie, vol. 90, pp. 258–273. 1930. (New: *Miniopterus ravus*, *Miniopterus witkampi*; also redescribes *Crocidura minuta* Otten.)

SOLANET, EMILIO. The criollo horse of South America. Journ. Heredity, vol. 21, no. 11, pp. 449–480, illus. November, 1930.

SPREHN, C. Parasiten und parasitäre Krankheiten beim Kaninchen. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 218–242, figs. 12. 1931.

STEIN, G. Beiträge zur Kenntnis einiger mitteleuropäischer Säuger. Mitteil. Zool. Mus. Berlin, vol. 17, no. 2, pp. 273–298. 1931. (New: *Neomys fodiens stresemanni*; *Microtus arvalis cimbricus*; *M.a. incognitus*; *Pitymys subterraneus atratus*.)

STEPHEN, A. C. Records of cetaceans stranded on the Scottish coast. Scottish Naturalist, no. 189, pp. 85–86. May–June, 1931.

STILES, C. W. AND M. O. NOLAN. Key catalogue of parasites reported for Chiroptera (bats) with their possible public health importance. U. S. Public Health Service, Nat. Inst. Health Bull. 155, pp. 603–742. 1930.

STONE, RALPH W. Pennsylvania caves. Pennsylvania Geol. Surv., ser. 4, Bull. G 3, pp. 1–63, figs. 1–34. 1930. (Mentions various mammals found in caves.)

STRONG, RICHARD P., J. C. BEQUAERT, AND L. R. CLEVELAND. Report on the available evidence showing the relation of game to the spread of tsetse fly borne diseases in Africa. Special Publ. Amer. Comm. Internat. Wild Life Protection, Cambridge, vol. 1. no. 1, pp. 1–46. 1931.

SVIHLA, ARTHUR. Change in color pattern in a captive red squirrel. Amer. Nat., vol. 65, no. 696, pp. 92–95, fig. 1. January–February, 1931.

SWIRE, C. Three tigers at a kill. Journ. Bombay Nat. Hist. Soc., vol. 34, no. 3, pp. 796–797. November 15, 1930.

TANZER, ERNST. Das Angorahaar und seine mechanischen Eigenschaften. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 104–113. 1931.

TERIAEV, W. A. Has the Elasmotherium been tridactylous? Ann. Soc. Paléont. Russie, vol. 8, pp. 77–82, fig. 1, (1928–29). 1930. (Russian with English summary.)

TINKLEPAUGH, O. L. Occurrence of vaginal plug in a chimpanzee. Anat. Rec., vol. 46, no. 4, pp. 329–332, fig. 1. September 25, 1930.

——— AND CARL G. HARTMAN. Behavioral aspects of parturition in the monkey (*Macacus rhesus*). Journ. Comp. Psychology, vol. 11, no. 1, pp. 63–98, figs. 1–3. October, 1930.

TROUGHTON, ELLIS LE G. A new species and sub-species of fruit-bats (Pteropus) from the Santa Cruz Group. Records Australian Mus., vol. 18, no. 1, pp. 1–4. November 10, 1930. (New: *Pteropus tonganus heffernani*; *Pteropus sanctacrucis*.)

——— The occurrence of a male and female Grampus griseus (Delphinidae) at Sydney, New South Wales. Proc. Zool. Soc. London, 1931, pt. 2, pp. 565–569, pl. 1. June, 1931.

TSCHAN, A. Die Kaninchenzücht der Schweiz. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 170–173. 1931.

TURKEWITSCH, B. G. Zur methodik der Anfertigung der das knöcherne innere Ohr betreffenden Präparate. Die Korrosion mit Dammaraharz (Gummi Dammara). Anat. Anz., vol. 72, nos. 1–3, pp. 42–45. April 25, 1931.

VANDER HOOF, V. L. Borophagus littoralis from the marine Tertiary of California. Univ. Calif. Publ., Bull. Dept. Geol. Sci., vol. 21, no. 2, pp. 15–24, pls. 1–3. November 5, 1931. (New: *Borophagus littoralis*.)

VAN HEURN, W. C. Biologische bijzonderheden van *Rattus r. roquei* Sody, vergeleken bij die van *Rattus r. jalorensis* Bonhote. Zool. Mededeel., Leiden, vol. 13, nos. 3–4, pp. 151–154. December 31, 1930.

VAUFREY, RAYMOND. Les Éléphants nains des îles méditerraneenes et la question des isthmes pléistocenes. Arch. Inst. Paléontol. Humaine Mém., Paris, no. 6, pp. 220, pls. 9, figs. 45. 1929. (Dwarf elephants of the Mediterranian islands, and the question of Pleistocene isthmuses; the three dwarf elephants, *Elephas mnaidriensis*, *E. melitensis* and *E. falconeri* (= *E. cypriotes*) are dwarf races of *E. antiquus*.)

VERNAY, ARTHUR S. The lion of India. Nat. Hist., vol. 30, no. 1, pp. 81–89. January–February, 1930.

VINOGRADOV, B. On the classification of *Dipodidae* (Rodentia). 1. Cranial and dental characters. Pt. 1. Bull. Acad. Sci. URSS., no. 4, pp. 331–350, pls. 6. 1930. (New: *Paradipus* for *Scirtopoda ctenodactyla; Eremodipus*, for *Scirtopoda lichtensteini*.)

——— On the classification of Dipodidae (Rodentia). 1. Cranial and dental characters. Pt. 2. Bull. Acad. Sci. URSS., no. 5, pp. 453–466, pls. 7–10. 1930.

VRTIS, V. Glandular organ of the flanks of the water rat, their development and changes during breeding season. Biologické Spisy. Acad. Veterinariae, Brno, vol. 9, no. 4, pp. 1–51. 1930.

WALKER, L. W. Economic value of predatory animals. Zool. Soc. San Diego, 1930, pp. 15, illus.

WALKER, M. V. Note on North American fossil Lagomorphs. The Aerend, Kansas State Teachers College Quarterly, Hays, vol. 2, no. 4, pp. 227–240, pl. 1. 1931. (New: *Protolaginae; Protolagus; P. affinus; Megalaginae; Megalagus* for *Palaeolagus turgidus* Cope; *Archaeolagus striatus*.)

WEINBRENN, CLARA. Variations in the skull of Cercopithecus aethiops pygerythrus. South African Journ. Sci., vol. 27, pp. 501–520. November, 1930.

WENDT, G. V. Beiträge zur Theorie der Kaninchenernährung Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 184–190. 1931.

WILSON, W. KING. On rabbit nutrition, with reference to work at Harper Adams College. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses. Leipzig, 1930, pp. 191–199. 1931.

WISCHER, MAX. Zur Frage internationaler Bewertungsbestimmungen für die Beurteilung von Kaninchen. Verhandl. des I. Internat. Kaninchenzüchter-Kongresses, Leipzig, 1930, pp. 178–183. 1931.

ZEDTWITZ, F. X. G. Neues aus dem Zoologischen Garten Berlin. Zool. Garten, n.F., vol. 4, nos. 1–2, pp. 13–16, figs. 1–3. February, 1931.

ZEDTWITZ, F. X. G. Kleine Ankäufe, Geschenke und seltene Nachzuchten 1930 im Zoologischen Garten Berlin. Zool. Garten, n.F., vol. 4, nos. 6–7, pp. 227–235, figs. 1–5. July, 1931.

CORRESPONDENCE

TO THE MEMBERS OF THE AMERICAN SOCIETY OF MAMMALOGISTS

Editor, Journal of Mammalogy:

I have long been interested in the accounts of how rats transport eggs. In the course of years of checking up various bibliographies for articles on fishes, I have accumulated a number of alleged accounts of methods of transportation. I am now desirous of going further into this matter. And I wish to ask if any of the readers of the Journal of Mammalogy have ever seen rats transporting hens' eggs, know of any references to the subject, and can tell me of figures (photographs or drawings) portraying such.

I shall greatly appreciate any communications on this subject.

E. W. GUDGER,
American Museum of Natural History,
New York, N. Y.

COMMENT AND NEWS

GOVERNMENT STARTS NEW BUFFALO HERD

Winnipeg, Man., November—A herd of buffalo from the government park at Wainwright, Alberta, have been transferred to Riding Mountain Park, Manitoba, according to word received by the Natural Resources Department of the Canadian National Railways. This is a continuance of the government's policy to establish buffalo herds in suitable parks throughout the Dominion. The parent herd at Wainwright contains more than 6000 animals, and the second largest herd is at Wood Buffalo Park on the boundary between Alberta and the Northwest Territories. Animals from the Wainwright herd have also been shipped to many of the world's famous zoos.

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